FARR

TECHNICAL MANUAL

LW9625

9-5/8” (24.4cm) 12K “Lightweight”

Hydraulic Power Tong

- *Specifications*
- *Operation*
- *Maintenance*
- *Assembly*

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MCCOY
MOVING GLOBAL ENERGY FORWARD

This manual covers the following models:

TONG MODEL	REV	DESCRIPTION
80-0820-4	3	Lightweight 9-5/8" tong with Rineer GA15-9.5 hydraulic motor, motor valve, chain sling with spring hanger, & safety door
80-0820-5	3	Lightweight 9-5/8" tong with Rineer GA15-9.5 hydraulic motor, motor valve, rigid sling, & safety door
80-0820-6	3	Lightweight 9-5/8" tong with Rineer GA15-9.5 hydraulic motor, motor valve, rigid sling, & safety door
80-0820-8	0	Lightweight 9-5/8" tong with Commercial hydraulic motor, motor valve, chain sling with spring hanger, & safety door
80-0820-9	1	Lightweight 9-5/8" tong with Denison M4D113 hydraulic motor, motor valve, rigid sling, & safety door
80-0820-11	0	Lightweight 9-5/8" tong with Rineer GA15-9.5 hydraulic motor, motor valve, chain sling with spring hanger, safety door, and dump valve
80-0820-14	0	Lightweight 9-5/8" tong with Commercial hydraulic motor, motor valve, rigid sling, & safety door.

NOTE: Some illustrations used in this manual may not exactly match your model of tong.

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WARNINGS

A "LOAD-BEARING DEVICE" IS A CHAIN SLING, RIGID SLING, SPREADER BAR ASSEMBLY, FRAME, OR ANY OTHER DEVICE THAT BEARS THE PARTIAL OR TOTAL WEIGHT OF THE EQUIPMENT FOR WHICH THIS MANUAL HAS BEEN PRODUCED

THE LOAD-BEARING DEVICE SUPPLIED BY MCCOY DRILLING & COMPLETIONS IS DESIGNED TO SUPPORT THE EQUIPMENT DESCRIBED IN THIS MANUAL. MCCOY DRILLING & COMPLETIONS WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO SUPPORT ANY OTHER PART, ASSEMBLY OR COMBINATION OF PARTS AND ASSEMBLIES. MCCOY DRILLING & COMPLETIONS WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO LIFT OR SUPPORT THE EQUIPMENT DESCRIBED IN THIS MANUAL IF THERE ARE ANY MODIFICATIONS TO THE LOAD-BEARING DEVICE, OR ANY ADDITIONS TO THE EQUIPMENT DESCRIBED IN THIS MANUAL THAT ADD WEIGHT TO THE EQUIPMENT, UNLESS SUPPLIED BY MCCOY DRILLING & COMPLETIONS.

WHEN RE-ASSEMBLING LOAD-BEARING DEVICES (CHAIN SLINGS, RIGID SLINGS, BACKUP LEGS, ETC.) NOTE THAT THE ASSOCIATED FASTENERS MUST BE TIGHTENED TO THE CORRECT TORQUE SPECIFIED FOR THAT SIZE OF FASTENER (SEE SECTION 3 - OVERHAUL). ANY THREADED FASTENER IN A LOAD-BEARING DEVICE MUST BE SECURED WITH RED OR BLUE LOCTITE™.

ANY REPLACEMENT FASTENER (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED.

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McCoy has made every effort to ensure the information contained in this document is accurate and current. This manual is intended to provide equipment operation and safety instructions for your equipment. However, McCoy does not warrant or guarantee that the information is either complete or accurate in every respect and the user of the manual should consult with its McCoy sales representative for any clarifications and updates.

The user of the manual shall protect, indemnify, and hold harmless McCoy and its directors, officers, employees, and agents from and against all liability for personal injury, death, or property damage resulting directly or indirectly from the use of the information contained in this manual.

Observance of all descriptions, information and instructions set out in this manual is the full responsibility of the user. This manual is intended for guidance and informational purposes and must be used in association with adequate training and on-the-job supervision to provide safe and effective equipment use.

It is the responsibility of the user to conform to all regulations and requirements issued by an authority or agency which may affect the operation, safety or equipment integrity, that may overrule the content of this documentation.

The user will acknowledge and obey any general legal or other mandatory regulation in force relating to accident prevention, safety, and equipment integrity.

Summary Of Revisions

Date	Section	Page	Description Of Revision
April 2005	N/A	N/A	Intial Release
January 2006	7	7.18 - 7.26	Added both door upgrades and safety door information
June 2007	Intro	iii	Added Summary Of Revisions table
	7	7.25	Corrected part number for Deltrol safety door valve
March 2008	N/A	Cover	Revised cover to new standard
	Intro	iii	Added table listing tong models, moved summary of revisions to Pg. vii
	Intro	v	Added standard warnings
	1	1.1	Revised introductory page & contact information. Replaced images to reflect new generation of tong.
	1	1.2	Improved images for dimensional data specifications
	1	1.3	Revised specifications to reflect Rineer or Denison motors
	7	7.2 - 7.3	Revised gear train layout
	7	7.16	Removed Commercial motor from graphic, added Rineer
	7	7.17	Revised parts table - removed references to Commercial, and added relevant parts numbers for Rineer & Commercial motors
	7		Removed all references to obsolete tong doors
	8	All	Revised torque gauge section
	9	9.1	Removed Commercial motor data, added Rineer and Denison motor information
May 2008	7	7.15	Corrected cam follower part number
JUN 2008	All		Consolidated all manuals into a single manual, added parts and assemblies for backup-ready tong.
	All	All	Created new graphics for all sections
AUG 2009	2	2.1	Added load-bearing device safety section
	3	3.10	Moved improved assembly instructions to maintenance section.
	Appendices		Added daily & monthly checklists, decommissioning and recommissioning checklists
March 2010	Intro	viii	Updated TOC to include New / Old Door Styles
	5	5.25 - 5.27	Changed door latch assembly number for old style door, added new style door assembly drawing
	N/A	N/A	Corrected references to section 6 throughout manual which should have referenced section 5

Continued on next page

SUMMARY OF REVISIONS (CONTINUED)				
DATE	**SECTION**	**PAGE**	**DESCRIPTION OF REVISION**	**APPROVAL**
May 2010	N/A	N/A	Revised manual format and logos	
Dec 2010	Intro	iii	Added new configuration	KI
	2	2.7	Revised schematic and hydraulic BOM to include dump valve	
	2	2.18 - 2.24	Added operating details	
	5	5.11	Corrected clutch BOM	
April 2011		iii	Corrected list of applicable models	KI
		ix	Corrected table of contents	
	1	1.3	Corrected ideal torque values	
	1	1.3	Corrected Dennison & Rineer speed tables	
	1	1.3	Added Commercial speed table	
	2	2.7	Corrected hydraulic bill of materials	
	5	5.4 - 5.5	Corrected rotary idler assembly drawing & parts list	
	5	5.12 - 5.13	Updated manual shifter assembly drawing & parts list	
	5	5.22 - 5.23	Added assembly drawing & parts list - Commercial motor	
	5	5.24 - 5.25	Updated brake band assembly drawing & parts list	
	5	5.32 - 5.33	Added assembly drawing & parts list - chain sling & lifting lug	
June 2011	3	3.10 - 3.18	Updated assembly instructions to reflect changes to cam follower spacer & washer part numbers	DB
	3	3.19	Moved maintenance checklists from appendices to maintenance section.	
	5	5.14 - 5.15	Updated diagram and bill of materials to reflect changes to cam follower spacer & washer part numbers	
	6	All	Complete revision of torque measurement section	
July 2011	5	5.27	Corrected part number for Item "X"	DB
	5	5.29	Corrected part number for Item "X"	
SEP 2011	5	5.27	Corrected part number for Item "Q"	DB
	5	5.29	Corrected part number for Item "Q"	
FEB 2012	All	All	Updated manual to comply with current branding standards	MM
	1	1.3	Corrected torque & flow specifications	
	2	2.15	Inserted new subsection 2.G.1, "Operator Training".	
	3	3.8	Inserted new subsection 3.E.3, "Safety Door Adjustment"	
		3.12 - 3.22	Revised Section 3.H, Mechanical Assembly Procedures	
	5	5.6 - 5.7	Corrected pinion idler graphics and B.O.M.	
	5	5.18 - 5.19	Replaced "Hydraulic Supports" graphic and updated B.O.M. to reflect equipment changes.	
		5.26 - 5.27	Replaced "Door Assembly" graphic and updated B.O.M. to reflect equipment changes.	
		5.28 - 5.29	Removed obsolete "Door Assembly - Old" graphics and B.O.M.	
	6	6.4	Removed irrelevant "Compression Load Cell" graphic	
MAR 2012	5	5.27	Part number for item "Z" (shoulder bolt) corrected	DB
JUN 2012	5	5.27	Part number for item "AA" (push-pill cable) corrected	DB

This technical manual represents the most current version of the equipment contained within. If older versions of this manual are required, please contact your sales representative.

The information presented in this document will provide setup, operating, and maintenance instructions for your LW9625 tong. Due to the wide variety of operating conditions, these instructions must be considered guidelines rather than absolute operating procedures. It is the responsibility of the user to use these guidelines together with an experienced manager to develop operating procedures that conform to all policies set forth by the operating authority (ies).

IDENTIFICATION OF OF WARNINGS AND OTHER NOMENCLATURE OF IMPORTANCE USED IN THIS INSTALLATION GUIDE

Farr Canada Corp. uses three indicators to describe items of three degrees of importance.

*A **HAZARD** to operators or equipment is represented by an exclamation point within a red triangle and identifies items of the highest importance. Failure to heed information identified by a **HAZARD** symbol may result in bodily injury, death, catastrophic equipment damage, or any combination of these. A **HAZARD** may also indicate the potential for dangerous environmental contamination.*

THIS IDENTIFIES A HAZARD TO OPERATORS OR EQUIPMENT

*A **WARNING** is represented by an exclamation point within an orange triangle, and contains information that will alert personnel to a potential safety hazard that is not life-threatening. A **WARNING** may also serve to alert the user to information critical to the correct assembly or operation of the equipment in use.*

THIS IDENTIFIES A WARNING TO USERS

*A **CAUTION** is represented by an exclamation point within a yellow triangle and highlights information that may aid the user during assembly or operation of your equipment. CAUTIONs are also used to ensure common errors are not made during assembly or operation of your equipment.*

THIS IDENTIFIES A CAUTION TO USERS

Observance of the following is the full responsibility of the user:

all descriptions, information and instructions set out in this manual

any regulation or requirement issued by an authority or agency which may influence operation, safety or integrity of the equipment that overrules the content of this document.

any legal or other mandatory regulation in force governing accident prevention or environmental protection.

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Congratulations on the purchase of your FARR® LW9625 9-5/8" tong. This unit will provide you with years of outstanding performance. Simple maintenance and care will extend its life and ensure years of excellent performance and reliability. The setup, operating, and maintenance instructions in this manual will assist you in giving your equipment the care it requires. Please carefully read the manual before installing and using your equipment. Replacement parts are readily available from McCoy Drilling & Completions | FARR in Edmonton Alberta. Note that many parts are transferable between FARR® tongs and backups. Should you need replacement parts, or should you experience any difficulty not covered in this manual, please contact:

McCoy Drilling & Completions | FARR

14755 121A Avenue
Edmonton, Alberta
Canada T5L 2T2
Phone: 780.453.3277
Fax: 780.455.2432

Sales Fax: 780.481.9246

Email Engineering: engFarr@mccoyglobal.com

Email Sales: salesFarr@mccoyglobal.com

Website: http://www.mccoyglobal.com/index.php/drilling-completions

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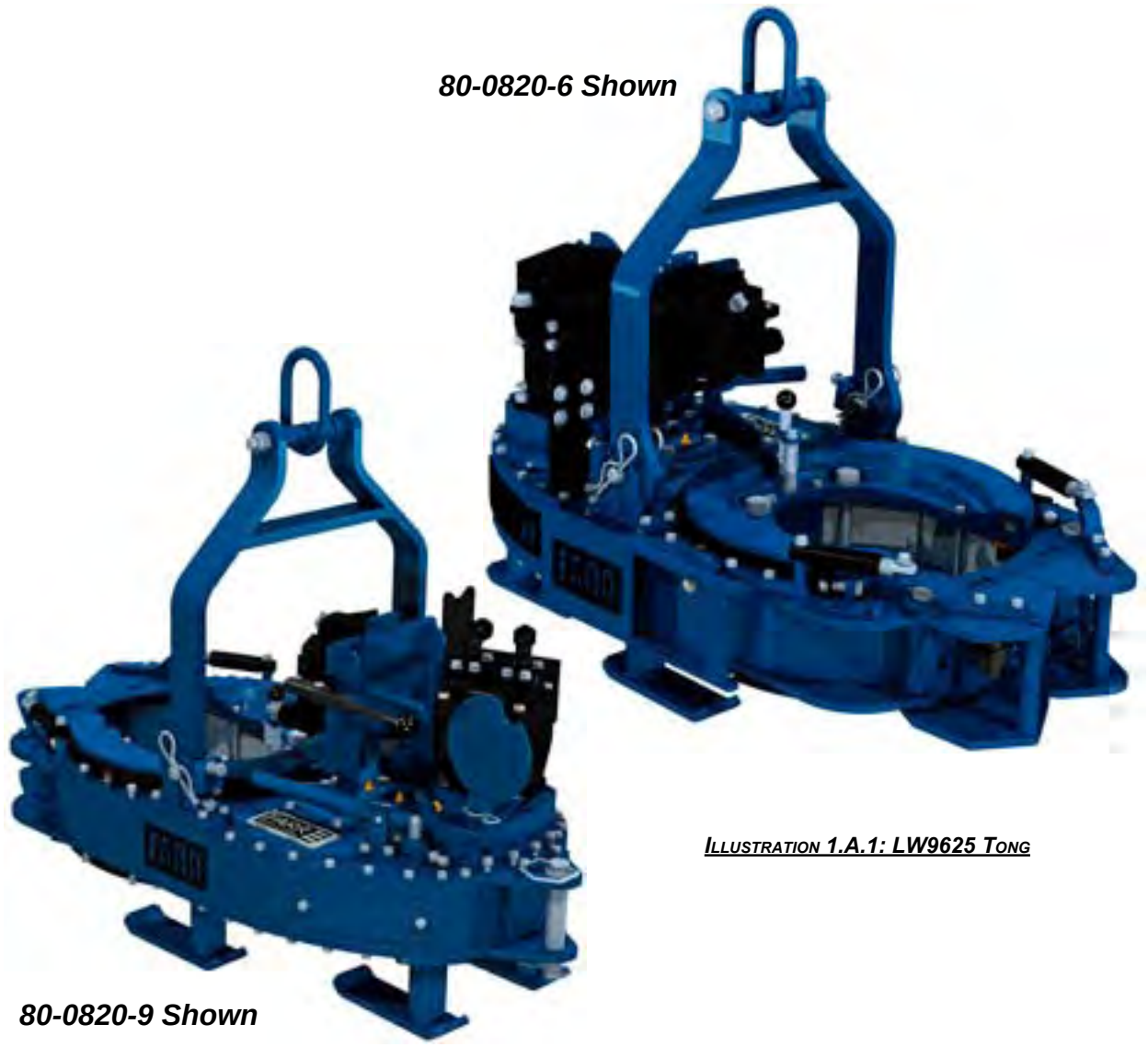

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ILLUSTRATION 1.A.1: LW9625 TONG

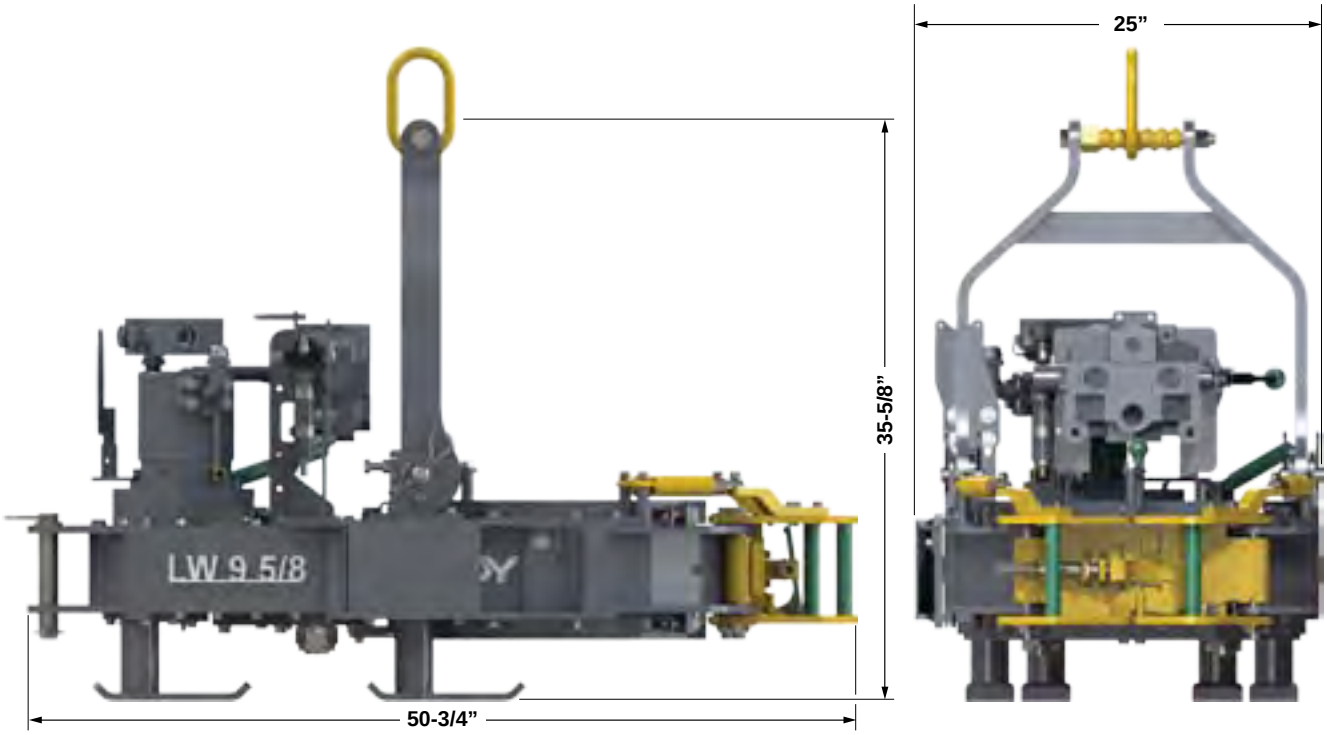

ILLUSTRATION 1.A.2: LW9625 TONG DIMENSIONS

Pressure	High Gear		Low Gear	
PSI / MPa	Lbs.-ft.	Nm	Lbs.-ft.	Nm
1000 / 6.89	975	1322	4900	6645
1200 / 8.96	1250	1695	6300	8542
1600 / 11.03	1800	2440	9000	12203
2000 / 13.79	2350	3186	11850	16066
MAXIMUM RATED TORQUE: 12000 LBS.-FT. / 16270 Nm **				

Speed Table (Rineer)		
Flow (US GPM / LPM)	Low Gear (RPM)	High Gear (RPM)
10 / 37.85	3	16
20 / 75.71	6	31
40 / 151.4	13	63
60 / 227.1	19	94

Speed Table (Denison)		
Flow (US GPM / LPM)	Low Gear (RPM)	High Gear (RPM)
10 / 37.85	2	6
20 / 75.71	5	24
40 / 151.4	10	49
60 / 227.1	15	73

Speed Table (Commercial)		
Flow (US GPM / LPM)	Low Gear (RPM)	High Gear (RPM)
10 / 37.85	2.9	14.5
20 / 75.71	5.8	28.9
40 / 151.4	11.5	57.9
60 / 227.1	17.3	86.7

** These are ideal values. Actual achieved torque is highly dependant upon tong efficiency, final position of rotary gear when full torque load is reached, and the motor with which the tong is equipped.

Maximum Hydraulic Requirements: 60 GPM (227.1 LPM)
2500 PSI (17.237 MPa)

Length: 50-3/4" / 128.9 cm

Overall Width: 25" / 63.5 cm

Height: 35-5/8" / 90.5 cm

Maximum Elevator Diameter: Unlimited (tong comes off pipe)

Torque arm length: 31 inches / 78.7 cm (Center Line of Pipe Center Line of Anchor Handle)

Weight (Approximate): 1200 Lbs. / 545 kg.

Jaws available (inches): All standard sizes from 2-3/8" to 9-5/8" (See Pg. 2.11)

Recommended Spring Hanger: 85-0106X (Capacity = 1800 Lbs.)

ALL REPLACEMENT FASTENER (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED.

Use an EP synthetic grease that meets or exceeds the following specifications:

Thickener	*Lithium Complex*
NLGI consistency grade	*2*
NLGI performance grade	*GC-LB*
Penetration - ASTM D 217 (25°C [77°F]	*265-295 minimum*
0.1 mm) worked 60 strokes	
Dropping point, °F[°C] - ASTM D2265	*550 [288] minimum*
High temperature life, hours - ASTM D 3527	*160 minimum*
Oxidation stability, psi - ASTM D 942	*(100 hr/300 hr) 0/3*
Water washout, percent - ASTM D 1264	*1.8 max*
Rust and corrosion - ASTM D 1743	*pass*
Oil separation, percent loss - ASTM D 1742	*1.1 max*
(24 hours, 25°C [77°F]	
Leakage, g lost - ASTM D 4290	*1.0 max*
Four ball wear test, mm scar - ASTM D 2266	*0.40 max*
Fretting wear, mg - ASTM D 4170	*3.4 max*
Four ball EP, kgf - ASTM D 2596	
Weld point	*400 minimum*
Load wear index	*50 minimum*
Timken OK load test, lbs - ASTM D 2509	*50*
*Low temperature torque, N*m - ASTM D 4693*	*1.3 max*
(-40°C [-40°F])	
LT-37 pumpability, g/min	*360/7*
(60°F/0°F [16°C/-18°C])	
Copper corrosion - ASTM D 4048	*1B*
Disc brake wheel bearing specifications	
Ford ESA-M1C 198A	*Yes*
Chrysler MS-3701	*Yes*
Oil viscosity: 40°C [104°F], cSt	*151*
100°C [212°F], cSt	*19.2*
Flash point, °F[°C] - ASTM 92	*450[232]*

Use a premium quality hydraulic fluid that meets or exceeds the following specifications:

Typical Density (kg/m^3)	*878*
Viscosity - cSt @ 40 °C	*68.8*
- cSt @ 100 °C	*8.7*
Viscosity Index	*97*
Pour Point °F [°C]	*-22 [-30]*
Flash Point °F [°C]	*432 [222]*
Colour, ASTM	*1.5*
Neutralization Number	*0.40*
Rust Protection - Distilled Water	*No Rust*
- Sea Water	*No Rust*
Hydrolytic Stability - Cu Mass Loss, mg/cm^2	*0.04*
Copper Corrosion Test	*1A*
Filterability: Denison - Wet & Dry	*Pass*
Afnor - Wet & Dry	*Pass*
Cincinatti Milacron Spec Approved	*P69*
Denison HF-0:	*Approved*
Denison P-46 Piston Pump:	*Pass*
Denison T6C Vane Pump:	*Pass*
Vickers 35VQ25 Vane Pump Test:	*Pass*
104/105C Vane Pump Test:	*No Data Available*
Vane pump test total ring and vane wear, mg.	*<10*
Oxidation Stability	
Turbine Oil Stability Test Life, hours	*2500+*
Rotary Bomb Oxidation Test, minutes	*325*
FZG Spur Gear Test, Failure Load Stage (FLS)	*12*

Adequate setup and proper hydraulic connections are essential in ensuring reliable operation of your tong. For best results and long term reliability, read and obey the start-up instructions in this section.

DO NOT ACCESS ROTATING COMPONENTS UNLESS HYDRAULIC POWER SUPPLY HAS BEEN DEACTIVATED OR ISOLATED.

A CLEARLY IDENTIFIED REMOTE POWER PACK EMERGENCY STOP MUST BE INSTALLED IN THE IMMEDIATE VICINITY OF THE TONG OPERATOR.

A. SLING / LOAD BEARING DEVICE SAFETY

THE SUPPLIED LOAD-BEARING DEVICE (CHAIN SLING, RIGID SLING, SPREADER BAR ASSEMBLY, FRAME, OR ANY OTHER DEVICE THAT BEARS THE PARTIAL OR TOTAL WEIGHT OF THE EQUIPMENT DESCRIBED IN THIS MANUAL) HAS BEEN SPECIFIED OR DESIGNED TO SUPPORT THE EQUIPMENT DESCRIBED IN THIS DOCUMENT. FARR WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO SUPPORT ANY OTHER PART, ASSEMBLY OR COMBINATION OF PARTS AND ASSEMBLIES, OR ANY ADDITIONS TO THE EQUIPMENT DESCRIBED IN THIS MANUAL THAT ADD WEIGHT TO THE EQUIPMENT, UNLESS SUPPLIED BY MCCOY DRILLING & COMPLETIONS.

MCCOY DRILLING & COMPLETIONS DOES NOT GUARANTEE THE INTEGRITY OF MODIFIED OR DAMAGED LOAD-BEARING DEVICES, UNLESS THOSE MODIFICATIONS ARE PERFORMED BY MCCOY DRILLING & COMPLETIONS.

McCoy Drilling & Completions recommends following an industry-accepted standard such as OSHA, ASME B30.9-2006, or manufacturer's guidelines when performing any rigging and overhead lifting. Use by untrained persons is hazardous. Improper use will result in serious injury or death. Do not exceed rated capacity. Slings will fail if damaged, abused, misused, overused, or improperly maintained.

- *Only grade 80 or grade 100 alloy chain should be used for overhead lifting applications.*
- *Working Load Limit (WLL) is the maximum allowable load in pounds which may be applied to the load-bearing device, when the device is new or in "as new" condition, and when the load is uniformly and directly applied. The WLL must never be exceeded.*
- *Working Load Limit (WLL) is the maximum working load for a specific minimum sling angle, measured from the horizontal plane. The Working Load Limit is identified on the sling.*
- *The Working Load Limit or Design factor may be affected by wear, misuse, overloading, corrosion, deformation, intentional alterations, sharp corner cutting action and other use conditions.*
- *Shock loading and extraordinary conditions must be taken into account when selecting alloy chain slings.*
- *See OSHA Regulation for Slings 1910.184, ANSI/ASME B30.9-"SLINGS", ANSI/ASME B30.10-"HOOKS" and ANSI/AMSE B30.26 "RIGGING HARDWARE" for additional information.*

THE MINIMUM SLING ANGLE (THE ANGLE OF THE LEG OF THE SLING MEASURED FROM THE HORIZONTAL) MUST NEVER FALL LOWER THAN THE ANGLE SPECIFIED FOR THE SLING IN USE

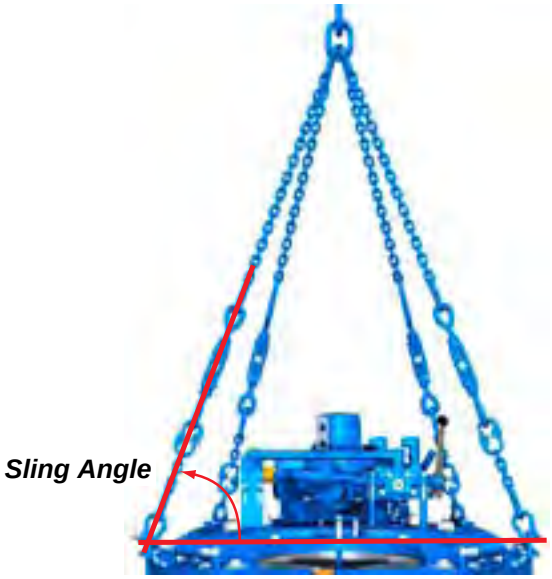

ILLUSTRATION 2.A.1: LW9625 SLING ANGLE

1. Inspection Of Slings

Farr strongly recommends the following practices:

A complete inspection of new load-bearing devices and attachments shall be performed by a qualified, designated person prior to initial use. Each link and component shall be examined individually, taking care to expose and examine all surfaces including the inner link surface. The sling shall be examined for conditions such as those listed in the removal criteria below. In addition, daily inspection of slings, fastenings and attachments shall be performed by a designated person. If damage or defects are found at either inspection, the damaged or defective component shall be quarantined from service until it can be properly repaired or replaced.

Removal Criteria:

A load-bearing device shall be removed from service if conditions such as the following are present:

- *Missing or illegible sling identification.*
- *Cracks or breaks*
- *Evidence of tampering is seen - sling tag has been modified or obscured, or tamper-proof nuts are missing.*
- *Signs of impact on load-bearing components, including spreader bars, lifting lugs, rigid slings & rigid sling weldments, and legs & leg mounts.*
- *Broken or damaged welds.*
- *Excessive wear, nicks, or gouges. Refer to the chart below to ensure minimum thickness on chain links supplied is not be below the values listed:*

Minimum Allowable Chain Link Thickness at Any Point			
Nominal Chain Size		**Minimum Thickness**	
Inches	MM	Inches	MM
7/32	5.5	0.189	4.80
9/32	7	0.239	6.07
5/16	8	0.273	6.93
3/8	10	0.342	8.69
1/2	13	0.443	11.26
5/8	16	0.546	13.87
3/4	20	0.687	17.45
7/8	22	0.750	19.05
1	26	0.887	22.53
1-1/4	32	1.091	27.71
Refer To ASME B30.9			

- *Stretched, bent, twisted, or deformed chain links or components.*
- *Evidence of heat damage.*
- *Excessive pitting or corrosion.*
- *Lack of ability of chain or components to hinge (articulate) freely.*
- *Weld splatter.*
- *For hooks, removal criteria as stated in ASME B30.10*
- *Other conditions, including visible damage, that cause doubt as to the continued use of the sling.*

Inspect all lugs and fixing points for signs of elongation and/or bending, or for material build-up around the hole. Repair or replace components that appear distorted. Ensure all hardware is tight and in good condition. Replace missing hardware if necessary. All hardware must be free of rust and corrosion.

Additional inspections shall be performed during sling use where service conditions warrant. Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on:

- *Frequency of use of the load-bearing device.*
- *Severity of service conditions*
- *Nature of lifts being made*
- *Experience gained on the service life of load-bearing devices used in similar circumstances.*

Guidelines for the interval are:

- *Normal Service - yearly*
- *Severe Service - monthly to quarterly*
- *Special Service - as recommended by a qualified person*

Units designed and manufactured in accordance with EN 12079 and DNV 2.7-1 should be tested and examined in accordance with the following schedule of examination and test. The user of the load-bearing device shall place a permanent placard or plate upon which the type and date of the last test shall be recorded. To avoid confusion, the plate shall not carry the date of the next test or examination, only the most recent.

Test / Examination				
Time / Interval	Lifting Tests[1]	Non-Destructive Examination (NDE) of Lifting Points	Thorough Visual Examination	Suffix To Be Marked On Plate Attached To Unit
Initial Certification By Farr / Superior	YES	YES	YES	T
Interval Not Exceeding 12 Months	At the discretion of inspection body	At the discretion of inspection body	YES	T or VN[3]
Interval Not Exceeding 60 Months	At the discretion of inspection body	YES	YES	T or VN
Following Substantial Repair or Alteration[4]	YES	YES	YES	T

1. Lifting test as per S 7.3 BS EN 12079 or DNV 2.7-1 May 1995
2. T = Proof Test, non-destructive examination; VN = non destructive examination and visual examination; V = visual examination.
3. Dependant upon whether non-destructive examination has been carried out.
4. For the purposes of this standard, a substantial repair or modification is defined as any repair and/or modification that has been carried out which may, in the opinion of the inspection body, affect the load-bearing elements of the container or lifting device, or elements that contribute directly to its structural integrity.

IF MECHANICAL DAMAGE IS SEEN OR SUSPECTED ON A LOAD-BEARING DEVICE, OR IF THE LOAD-BEARING DEVICE HAS BEEN OVERLOADED, IT MUST BE REMOVED FROM SERVICE AND QUARANTINED UNTIL RECERTIFIED

Written records of the most recent periodic inspection shall be maintained, and shall include the condition of the sling.

2. *Proper Use Of Load-Bearing Devices*

Whenever any load-bearing device is used, the following practices shall be observed.

- *Load-bearing devices that are damaged or defective shall not be used.*
- *Slings shall not be shortened with knots or bolts or other makeshift devices.*
- *Sling legs shall not be kinked.*
- *Load-bearing devices shall not be loaded in excess of their rated capacities.*
- *Slings shall be securely attached to their load.*
- *Load-bearing devices shall be protected from snagging, and shall not be further obstructed by any object.*
- *Suspended loads shall be kept clear of all obstruction.*
- *All employees shall be kept clear of loads about to be lifted and of suspended loads.*
- *Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.*
- *Shock loading is prohibited.*
- *Do not stand directly under a load during lifting.*

3. *Storage Of Load-Bearing Devices*

Proper storage of out-of-service load bearing devices is important to ensure full integrity of the device once it is returned to service. Farr recommends observing the following practices.

- *Wipe off all excess grease. Use a solvent-based cleaner on rags to wipe all external surfaces to remove residual grease or hydraulic fluid. Once the outside surfaces have been de-greased, wipe all external surfaces with clean water to remove residual solvent.*
- *Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external surfaces. Refer to manufacturer data sheets for proper application and safety information. Allow the anti-corrosive coating ample time to dry - refer to manufacturer data sheets for drying times at room temperature.*
- *Store in a clean, dry location. When returning to service, note that a full inspection of the device must be performed.*

B. MAJOR COMPONENT IDENTIFICATION

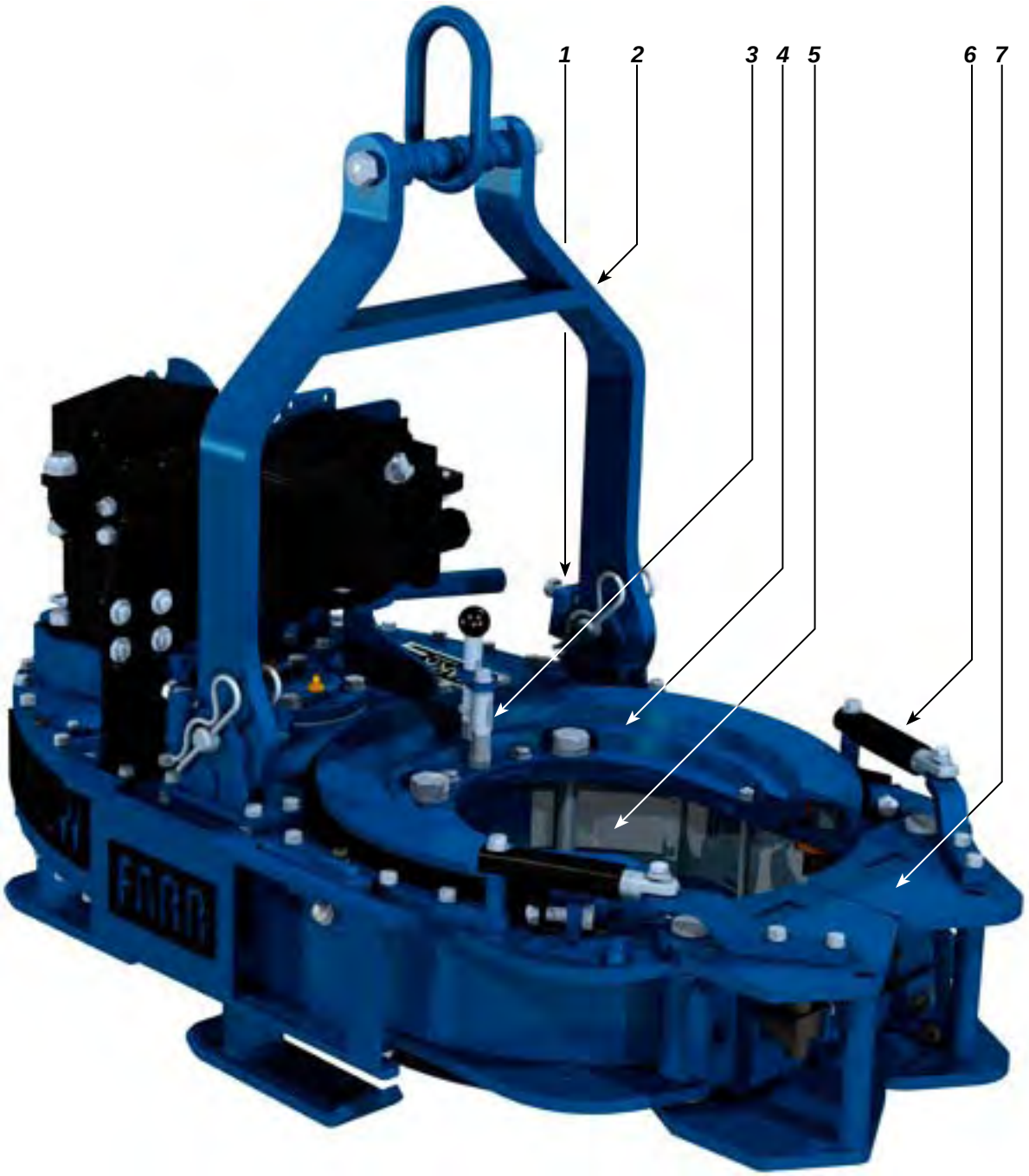

ILLUSTRATION 2.B.1: LW9625 COMPONENT IDENTIFICATION 01

Item	Description
1	Tong Leveling Adjustment
2	Rigid Sling
3	Backing Pin Assembly
4	Cage Plate Assembly
5	Tong Jaws with Die Inserts
6	Tong Door Cylinder
7	Tong Doors

ILLUSTRATION 2.B.2: LW9625 COMPONENT IDENTIFICATION 02

Item	Description
8	Safety Door Assembly (if equipped)
9	Brake Band Adjustment
10	Tong Door Latch

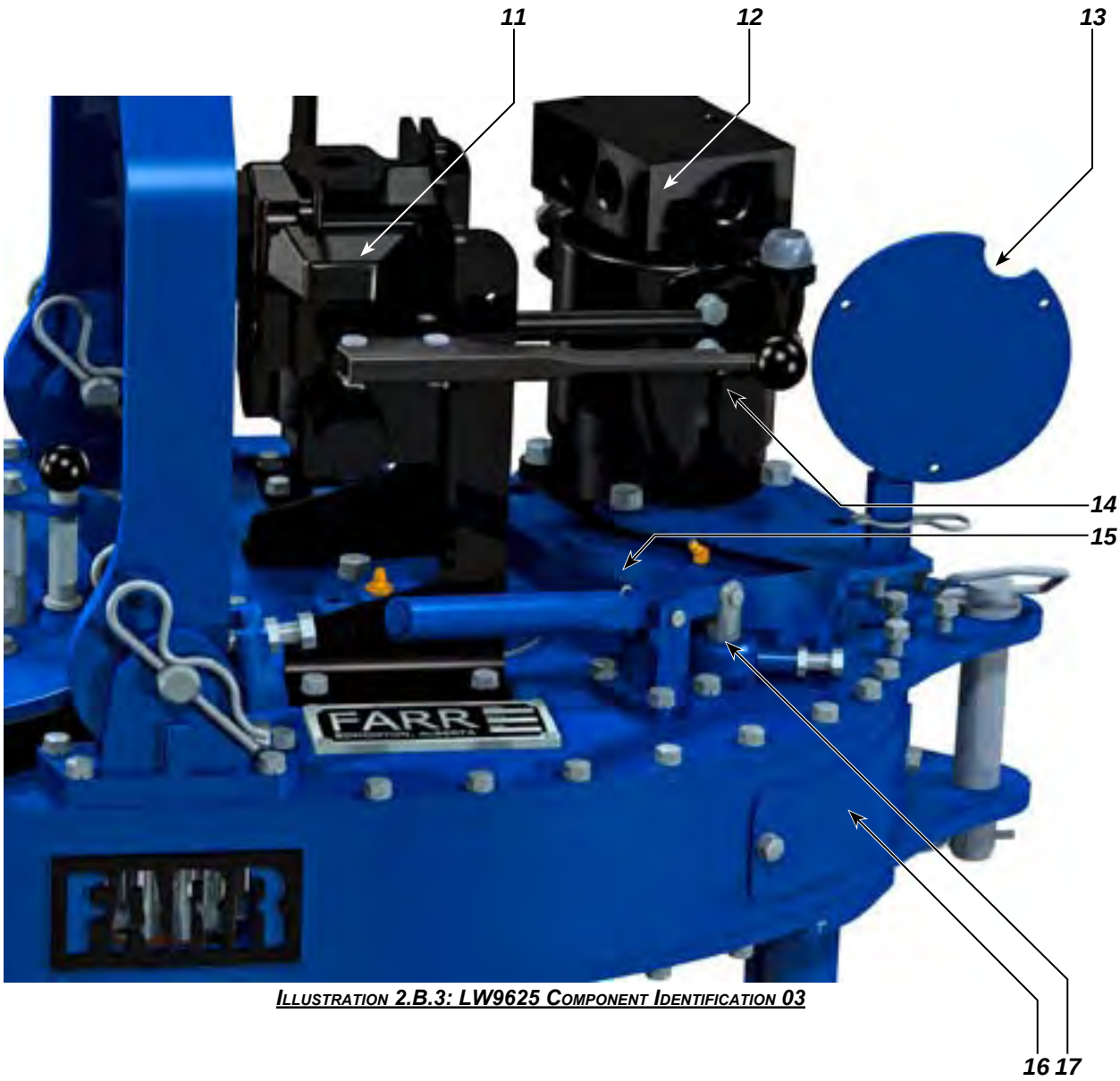

ILLUSTRATION 2.B.3: LW9625 COMPONENT IDENTIFICATION 03

Item	Description
11	Hydraulic Valve Assembly & Mounting Plate
12	Safety Door Valve & Valve Block Assembly (where equipped)
13	Torque Gauge Mounting Plate
14	Hydraulic Motor
15	Motor Mount
16	Inspection Panel
17	Manual Shift Assembly

C. HYDRAULIC SCHEMATICS & VALVE IDENTIFICATION

Your tong may be equipped with one, two, or three control valves, depending upon the specific model. Disregard the optional hydraulic parts indicated on the following schematics that do not apply to your model.

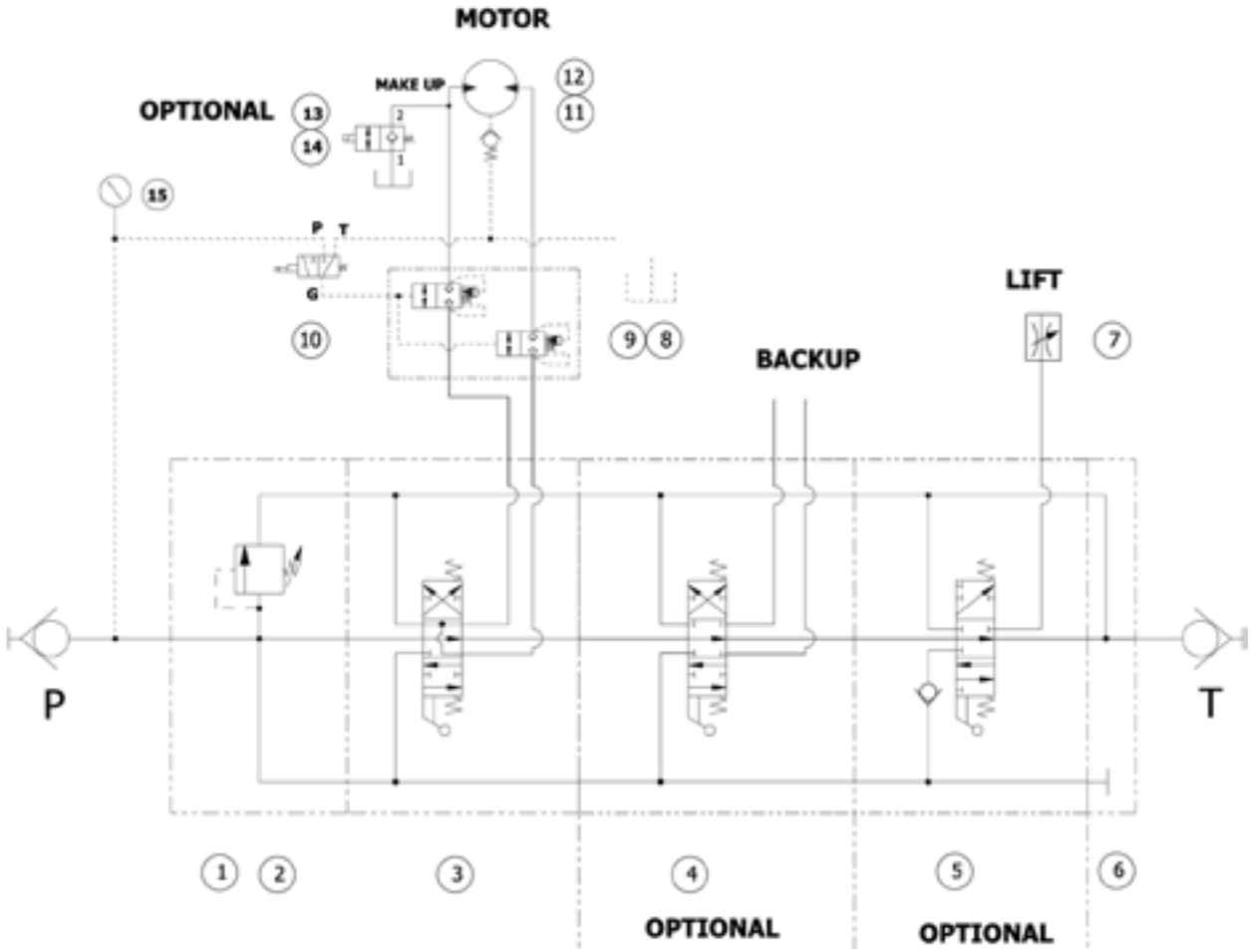

ILLUSTRATION 2.C.1: LW9625 HYDRAULIC SCHEMATIC

Item	Description	Part Number	Page
1	Inlet Valve. DVA35-A880 w/2500 TO 3500 DVG35 HMRV CARTRIDGE	10-9016	2.8
2	Relief Valve, DVA35-MRV-1	10-0010R	2.8
3	Motor Section, DVA35-MA8, 4WAY SAE PORTS	10-9014	2.8
4	Backup Section, DVA35-DA8, SAE PORT (Optional)	10-9019	2.8
5	Lift Cylinder Section, DVA35-SA8, (1" ORB PORT) (Optional)	10-9015	2.8
6	Outlet Section, DVA35-TR99, SAE PORT	10-0086	2.8
7	Flow Control Valve, Parker N800S	08-9062	Not Shown
8	LKHC-XDN Pilot-To-Operate Cartridge Valve	08-1625	2.8
9	Safety Door Valve Block	101-0727	2.8
10	Safety Door Switch	08-0337	2.9
11	Check Valve	02-9022	2.8
12	Hydraulic Motor (Varies with tong model)	Varies	2.8
13	Dump Valve (Optional)	08-9284	2.9
14	Dump Valve Body (Optional)	08-9283	2.9
15	0 - 3000 psig pressure gauge	02-0245	Not Shown

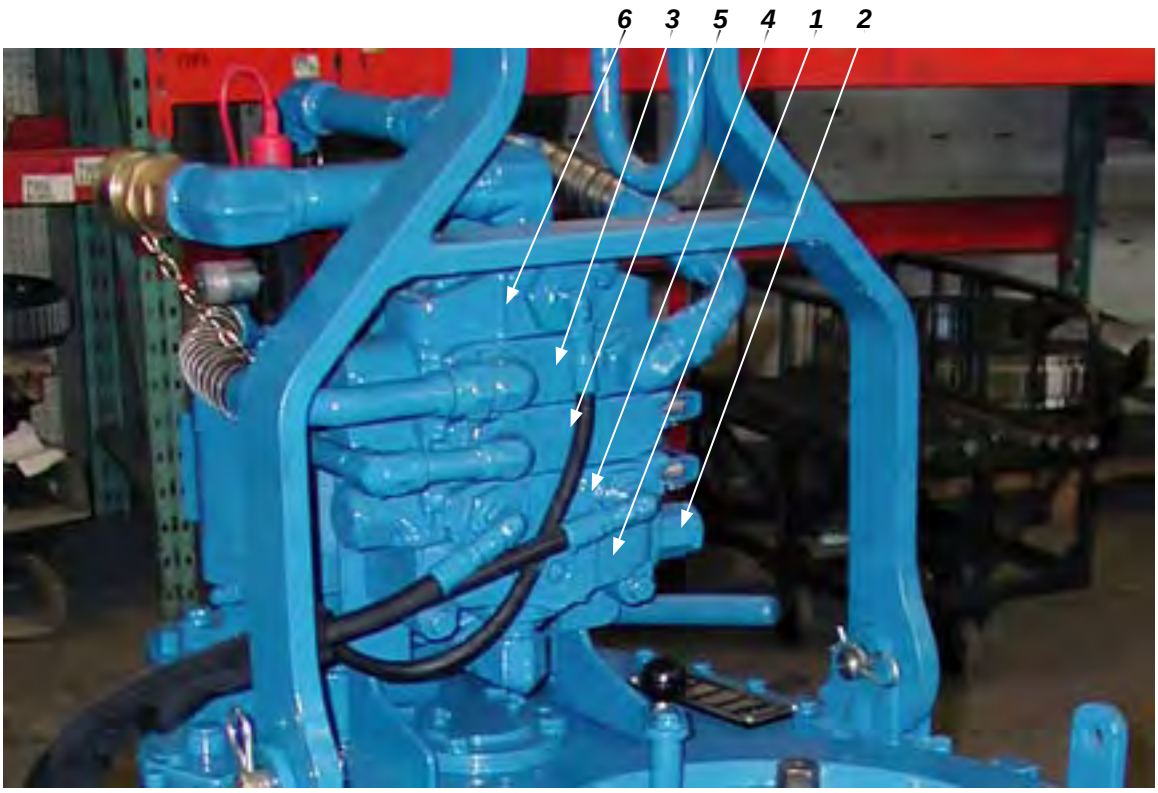

Illustration 2.C.2: LW9625 Hydraulic Component Identification 01

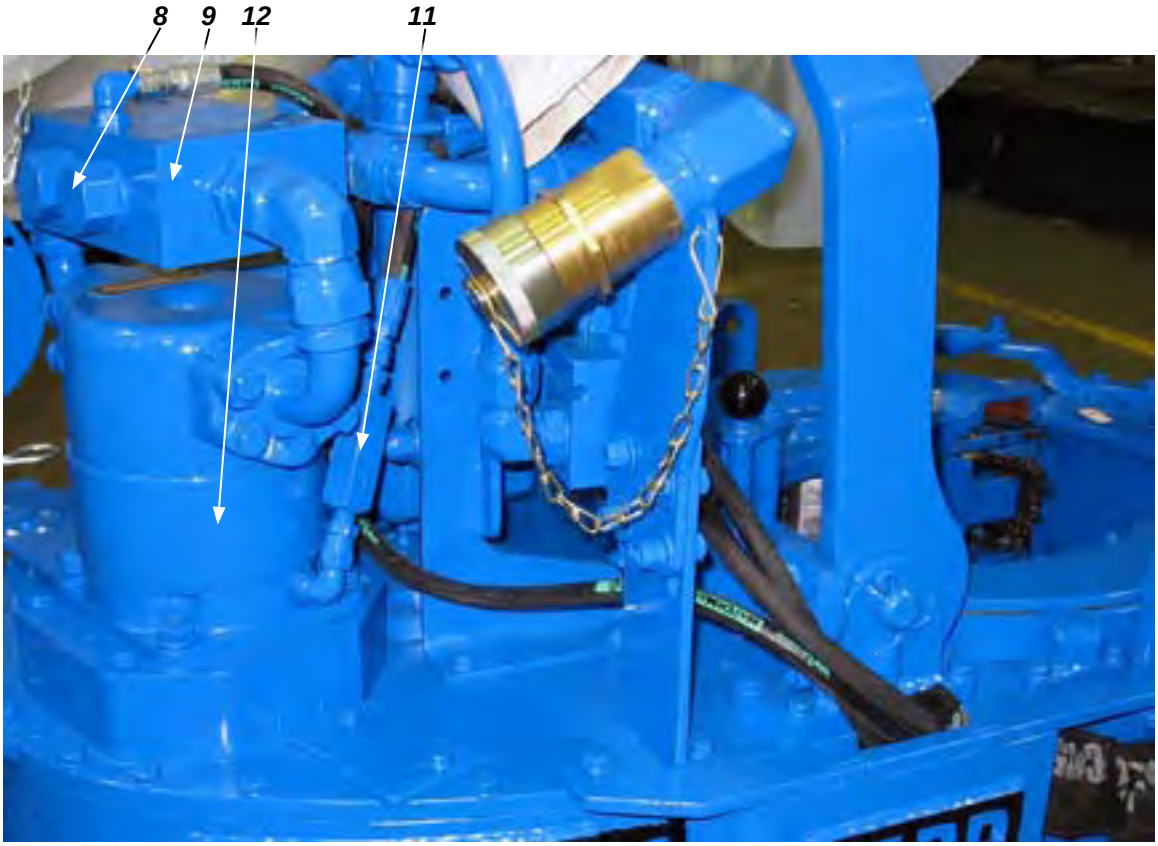

Illustration 2.C.3: LW9625 Hydraulic Component Identification 02

ILLUSTRATION 2.C.4: LW9625 HYDRAULIC COMPONENT IDENTIFICATION 03

ILLUSTRATION 2.C.5: LW9625 HYDRAULIC COMPONENT IDENTIFICATION 04

D. HYDRAULIC CONNECTIONS

A pair of hydraulic lines - a 1" supply line and a 1-1/4" return line - connect the tong to the power unit (see illustration below). Ancillary devices (hydraulic motors, hydraulic cylinders, etc.) are connected through the valve block.

Perform any hydraulic connection when the power unit is not running, or when the hydraulic pump is disengaged. The possibility of error in inter-changing the high pressure supply hose and the low pressure return hose has been eliminated, because the supply side coupling is smaller than the return side.

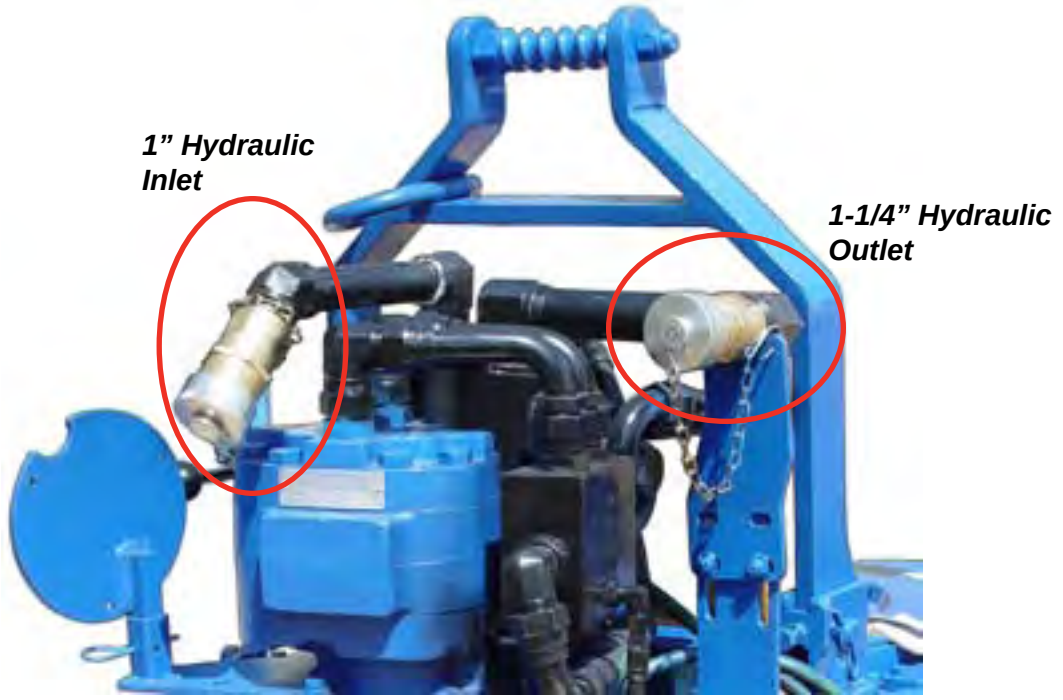

ILLUSTRATION 2.D.1: LW9625 HYDRAULIC CONNECTIONS 01

These hose couplings are self-sealing, and care should be taken to ensure complete engagement to prevent partial closure of the check valve in the coupling. Ensure that the nut (female) side is completely made up onto the male connector - there is a line on the male fitting that indicates complete make-up. Snug the female fitting right up to the line.

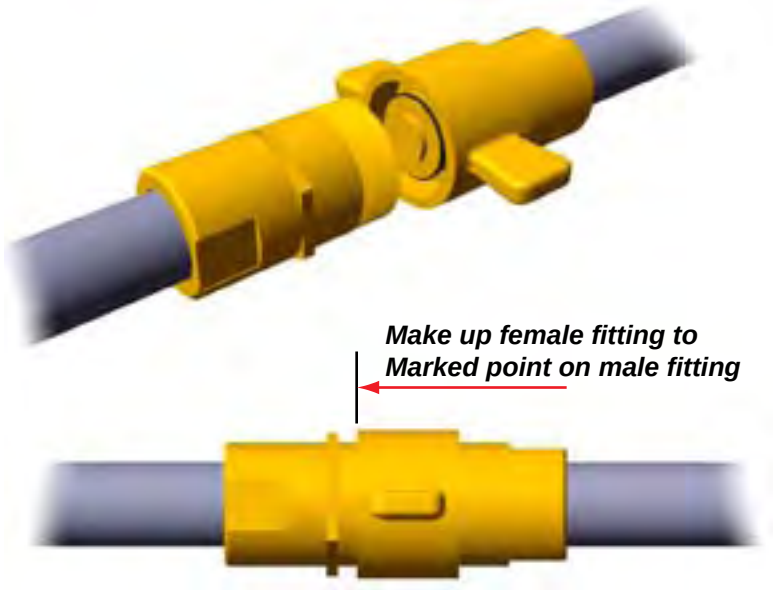

ILLUSTRATION 2.D.2: LW9625 HYDRAULIC CONNECTIONS 02

E. TONG / BACKUP JAW AVAILABILITY & INSTALLATION

1. Available Tong Jaws

The following table lists all jaw die kits that are available as standard sizes for this model of tong. If your desired size is not listed, Farr can engineer custom jaw sizes - contact sales for further information.

Description	Part Number
2-7/8" Jaw Die Kit	AK21-JDK-2875
3-1/2" Jaw Die Kit	AK21-JDK-3500
4" Jaw Die Kit	AK21-JDK-4000
4-1/2" Jaw Die Kit	AK21-JDK-4500
5" Jaw Die Kit	AK21-JDK-5000
5-1/2" Jaw Die Kit	AK21-JDK-5500
5-3/4" Jaw Die Kit	AK21-JDK-5750
6-5/8" Jaw Die Kit	AK21-JDK-6625
7" Jaw Die Kit	AK21-JDK-7000
7-5/8" Jaw Die Kit	AK21-JDK-7625
8-5/8" Jaw Die Kit	AK21-JDK-8625
9-5/8" Jaw Die Kit	AK21-JDK-9625
All jaw die kits use flat die PN 12-1004	

If necessary the entire jaw may be removed. Support the jaw from the bottom and remove the jaw pivot bolt. The jaw may then be slid out of and away from the cage plate. Reverse this procedure to replace the jaw assemblies

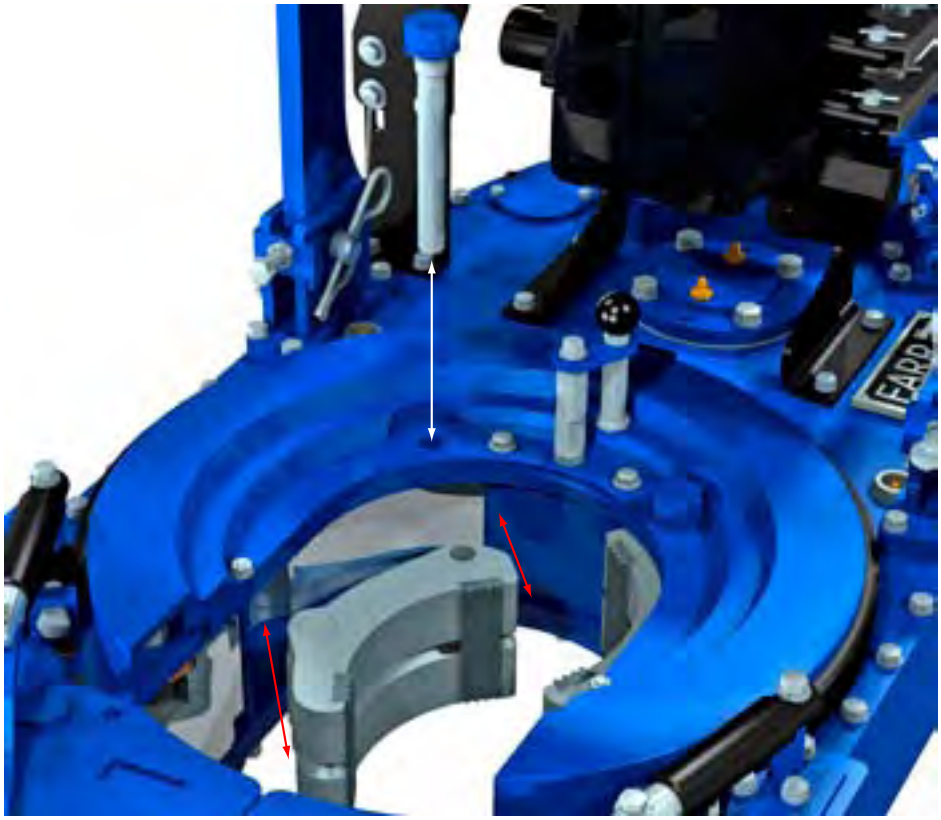

ILLUSTRATION 2.E.1: LW9625 JAW REPLACEMENT

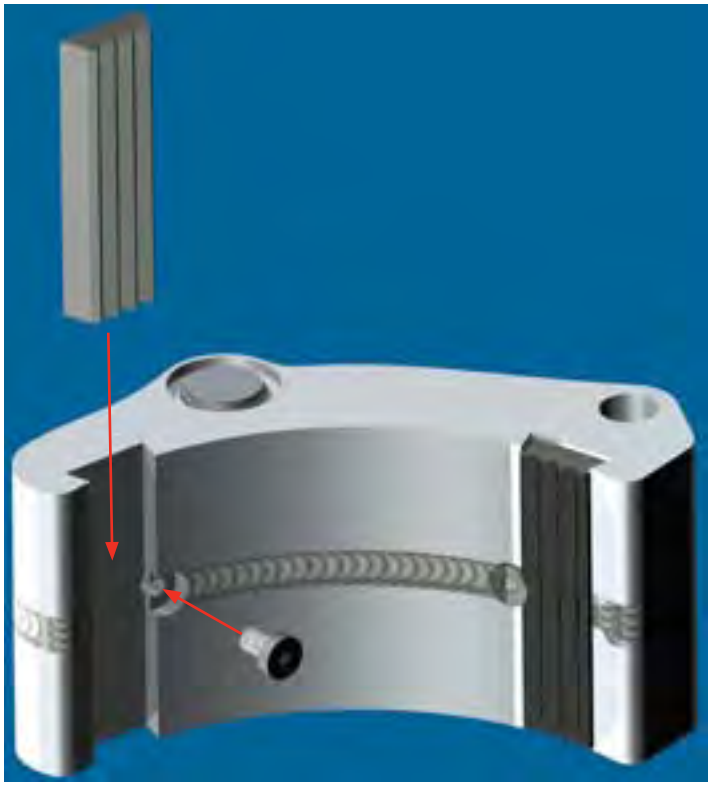

ILLUSTRATION 2.E.2: LW9625 JAW DIE REPLACEMENT

Once the jaw has been removed the jaw dies may be replaced by removing the keeper screw above the die, and tap the die from jaw using a hammer. Replace the die, tapping it into place if necessary, and replace the keeper screws.

F. TONG RIG-UP & LEVELING

1. Suspension & Restraint

Suspend the tong from a location as near to the centre of the drill rotary as possible, and from a location high enough on the mast to ensure easy handling. The lower the point from which the tong is suspended, the more effort will be required to move the tong to and from the connection point.

The suspension line may be extended over a pulley and balanced by a counterweight equal to the weight of the tong, or simply tied off in the derrick to form a dead line. When using a dead line arrangement it is necessary to use a FARR spring hanger assembly (see specification page for recommended spring hanger). This spring hanger compensates for the downward movement of the casing as the thread is made-up, and imparts additional force to the suspension cable:

- *a "single spring" hanger typically applies 420 lbs. (191 kg.) to the suspension line for every inch of thread made up*
- *a "double spring" hanger typically applies 840 lbs. (382 kg.) to the suspension line for every inch of thread made up*

If you do not know which specific spring hanger is in use, check the specification page in this manual for information on the recommended spring hanger for this application. McCoy Drilling & Completions will not guarantee or specify spring hangers other than what has been supplied by McCoy.

Many applications use a lift cylinder for adjusting the height of the tong. Ensure the weight of the lift cylinder is known if it has not been included in the total weight of the tong.

All forces upon the suspension line must be considered when calculating necessary strength of the suspension line. The weight of the tong, the weight of the lift cylinder, the weight of the spring hanger, and the force imparted on the suspension line by the spring hanger must all be added together in order to arrive at the total force supported by the suspension line. Select your suspension line based upon the total force and the margins of safety dictated by the policies of your company and by established engineering practices. Ultimately, calculating the force on the suspension line and selection of the suspension line is the complete responsibility of the customer.

McCoy Drilling & Completions recommends using dual backup (snub) lines of sufficient strength to withstand the force imparted by the maximum rated torque of the tong in use. Calculate the force on the snub lines by dividing the maximum torque of the tong by the tong's torque arm (expressed in feet). For example, an 18,000 lbs.-ft. tong with a 31 inch (2.583 ft.) torque arm will generate 6968.6 lbs. of force against the snub line. Select your snub lines based upon the total force and the margins of safety dictated by the policies of your company and by established engineering practices. Ultimately, calculating the force on the snub line and selection of the snub line is the complete responsibility of the customer.

Suspension & Restraint (Cont'd)

Snub lines must be securely connected to the rear of the tong, and tied off to a suitable anchor. One snub line must be secured to the load cell, which is then secured to the rear of the tong. The side of the tong the load cell connects to is dependant upon whether make-up or break-out activities are underway. To ensure accurate torque measurement, the torque measurement line must be connected perpendicular to the lengthwise axis of the tong, and perpendicular to the hang line (see illustrations 2.F.1 and 2.F.2). Connect the second snub line on the opposite side of the load cell, perpendicular to the lengthwise axis of the tong and perpendicular to the vertical.

MCCOY DRILLING & COMPLETIONS ACCEPTS NO RESPONSIBILITY FOR DESIGNING AND SELECTING AN ADEQUATE SUSPENSION AND RESTRAINT SYSTEM FOR YOUR DRILLING EQUIPMENT

ALL SELECTED FASTENERS, SHACKLES, CLAMPS, ETC. USED FOR CONSTRUCTING THE SUSPENSION AND SNUB LINES MUST BE RATED FOR THE CALCULATED FORCES.

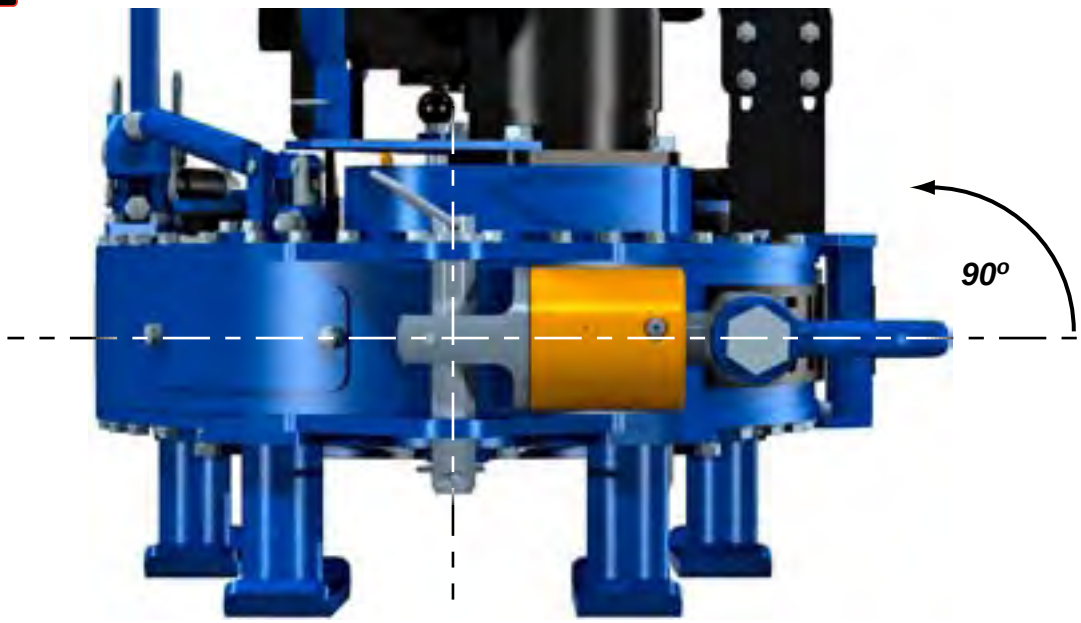

ILLUSTRATION 2.F.1: TONG SUSPENSION RELATIVE TO VERTICAL CENTRE

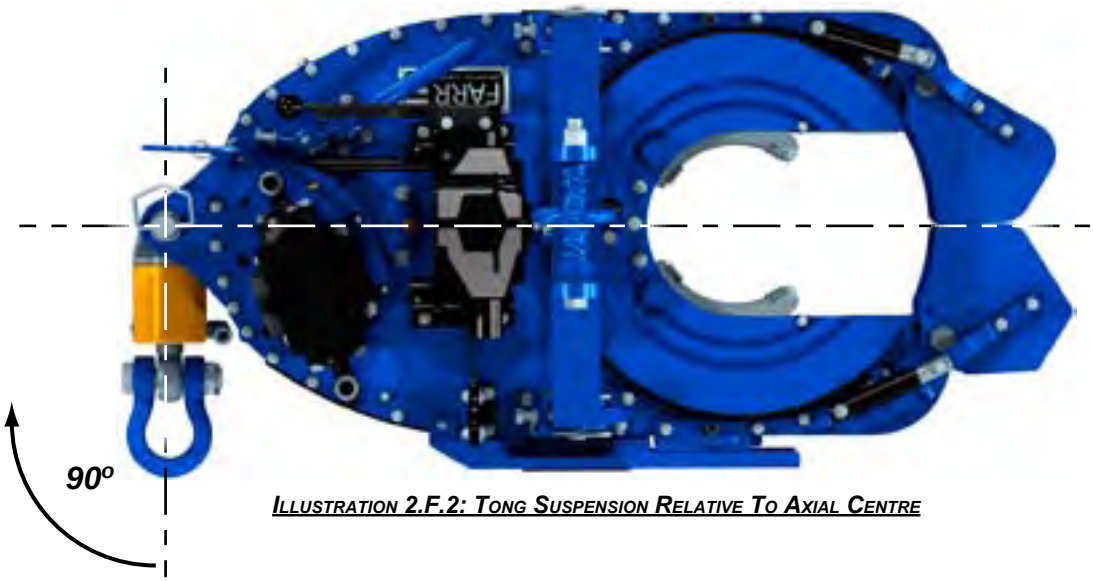

ILLUSTRATION 2.F.2: TONG SUSPENSION RELATIVE TO AXIAL CENTRE

2. Tong Leveling

The tong must be leveled side-to-side and front-to-rear before placing into service. The following guidelines will assist you when leveling your tong.

i. Place a level axially (side to side) across the tong, ensuring that it is parallel with the surface of the tong. Use a thin wrench on the flat of the adjusting helix to rotate the helix, forcing the lift link to move towards the outer supports of the sling. The 3/4" nylock nut on the pin may have to be slightly loosened to allow the helix to rotate. Adjust the helix until the level shows that the tong is level side-to-side.

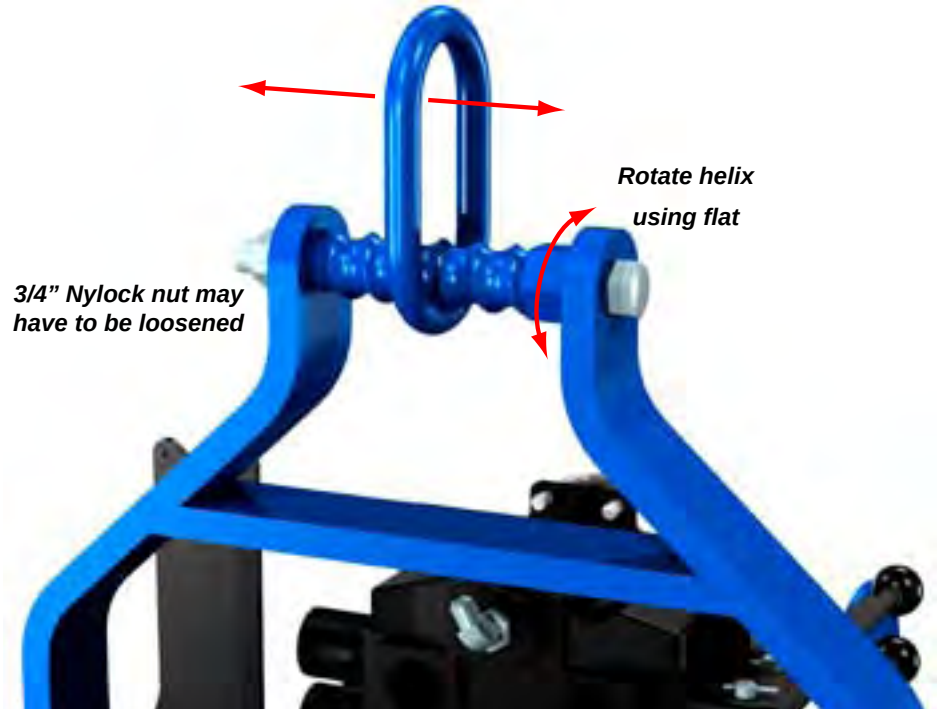

ILLUSTRATION 2.F.3: TONG LEVELING 01

ii. Place a level lengthwise (front to back) along the tong, ensuring that it is parallel with the surface of the tong. Loosen the 1/2" jam nuts on the adjusting bolts on rigid sling brackets. Completely loosen the adjusting bolts. Turn each adjusting bolt equally until tong hangs level front-to-back. Lock adjusting bolts in place with the jam nuts.

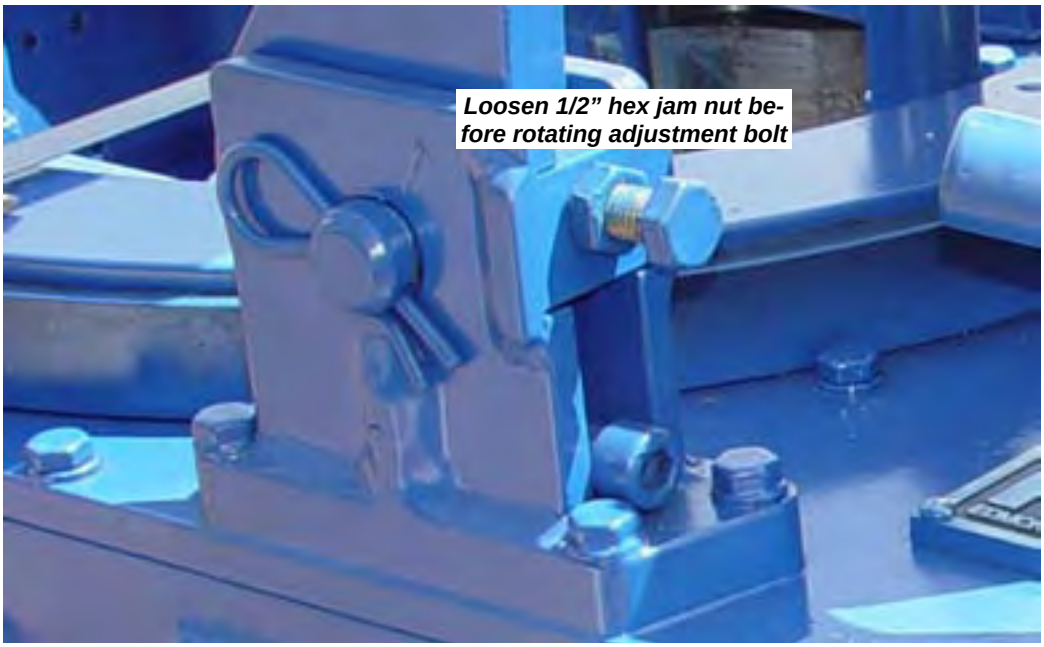

ILLUSTRATION 2.F.4: TONG LEVELING 02

G. TONG OPERATION

1. Operator Training

Many companies set qualification standards that must be met before equipment may be operated without supervision. McCoy Drilling & Completions recommends operator training, which typically consists of operation of the equipment under the supervision of a trained equipment operator until a satisfactory level of competence is achieved. Typical operator training should include:

- *Introduction to and general description of equipment*
- *Technical specifications and performance data*
- *Operating instructions*
- *Control systems and interlocks*
- *Operating hazards*
- *Checks and inspections*

2. Initial Start-up and Break-in Procedure

YOUR EQUIPMENT HAS BEEN THOROUGHLY TESTED AND INSPECTED AT THE FACTORY. HOWEVER, WE ADVISE TESTING OF YOUR NEW TONG AFTER TAKING POSSESSION IN ORDER TO ELIMINATE THE POSSIBILITY OF SHIPPING DAMAGE.

Farr recommends that the following pre-operating tests be performed prior to releasing the tong assembly to a operational environment:

- *Operate the tong at full speed and in high gear for a duration of one-half hour.*
- *Switch to low gear and operate for an additional one-half hour at full speed.*
- *Run the backup through several clamp/un-clamp sequences to ensure functionality.*
- *Inspect all components and hydraulic fittings for possible defects following completion of the tests. All FARR Tongs have been thoroughly tested at the factory prior to shipping, but shipping damage must be identified before running the tong in an operational environment.*
- *Carefully inspect the safety door components, and test to ensure that the safety device on each door is operating correctly before releasing the tong to the operating environment.*

DOOR MUST BE CLOSED AND SECURELY LATCHED BEFORE THE POWER UNIT IS STARTED IN ORDER TO ASSURE THE SAFETY OF OPERATING PERSONNEL

Ensure adequate lube oil and hydraulic oil levels before starting engine. Use start up procedures as recommended by the power unit engine operator's manual. Open the Bypass Valve on the hydraulic system, and inspect all pressure and return line hose connections to ensure correct and secure installation.

IMPROPERLY SECURED HYDRAULIC CONNECTIONS WILL INTERRUPT HYDRAULIC FLUID FLOW, AND COULD RESULT IN THE FOLLOWING FAILURES:

- *A restriction in the pressure supply hose will result in high pressure within the power unit hydraulic system, which will activate the hydraulic governor and increase the engine speed to as high as maximum RPM.*
- *A restriction in the return line will result in high pressure within the power unit and the tong hydraulic system, causing engine speeds as high as maximum RPM, and possible failure of the motor seal.*

Following inspection of the hoses, start the engine and allow it to idle until warm. Allow hydraulic fluid to circulate for approximately 10 minutes, then slowly close the Bypass Valve to allow hydraulic fluid to circulate through the hoses and to the tong (circulating pressure should not exceed 200 psi). Place the tong gear shifter in low gear and rotate the tong slowly forward and then reverse with the throttle valve control lever. Once this has been done and the proper size jaws have been installed, the tong is then ready to run pipe.

3. Valve Operation

4-way proportional valves control operation of hydraulic devices on the tong assembly such as hydraulic motors and cylinders. When any one valve is "centered" or in the detent position, there is no hydraulic output from the valve. When the valve is pushed forward there is an effect, and when the valve is pulled back, there is an opposite effect. These valves feature proportional control, which means that further extension of the valve handle (thereby further opening the valve orifice) results in proportionally higher hydraulic output to the controlled device.

Valve Operation (continued):

The following illustrations demonstrate the type and effect of the hydraulic valves with which this tong is may be equipped.

TONG MOTOR

This is a proportional valve. Pushing the valve handle forward will cause the tong motor to rotate in a clockwise direction (as seen from the top of the tong). This is the desired direction of rotation for making up a joint. Pulling the valve handle in the opposite direction results in counter-clockwise rotation, which is the desired direction of rotation for breaking out a joint.

ILLUSTRATION 2.G.1: TONG MOTOR VALVE

LIFT CYLINDER

This is a direct-acting valve. Pushing the valve handle forward will cause the lift cylinder to lift the tong vertically. Pulling the valve handle in the opposite direction will cause the lift cylinder to lower the tong.

ILLUSTRATION 2.G.2: TONG LIFT CYLINDER VALVE

BACKUP (Backup-Ready Tongs Only)

This is a two-way direct acting valve, without proportional control. Pushing the valve handle forward will cause the backup to engage. Pulling backward, towards the operator, reverses the operation.

ILLUSTRATION 2.G.3: TONG BACKUP CYLINDER VALVE

4. *Shifting Gears*

The shifting shaft has three "detent" positions identifying the low speed/high torque position, the "neutral" or free-spinning position, and the high speed/low torque position. The detent strength may be adjusted by releasing the locknut on the detent tube and increasing or relaxing pressure on the detent spring. Ensure the locknut is tightened once the desired detent pressure has been set.

To shift to the high-speed gear, move the shifting handle upward from neutral position. To shift to the low-speed gear, move the shifting handle down through the neutral detent to its lowest position. Note that the high clutch gear or the low clutch gear may not be exactly aligned when shifting, so the operator may need to "bump" the motor control handle slightly to turn the main clutch gear shaft and shifting collar into alignment. This is most effective when applying a small amount of pressure on the gear shift lever in the direction you want to shift the tong, ensuring the shifting collar will "catch" when the main clutch gear aligns with either the high or low clutch gear.

DO NOT SHIFT TONG WHILE ROTATING THE MOTOR AND CAGE PLATE. CATASTROPHIC GEAR TRAIN FAILURE MAY RESULT.

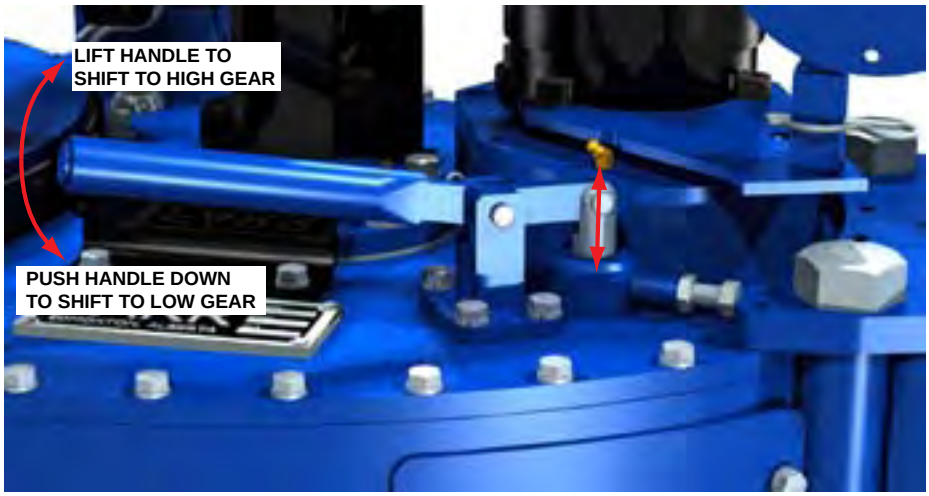

ILLUSTRATION 2.G.4: TONG MANUAL SHIFTER

5. GENERAL COMMENTS

a) *Position rotary gear in contact with both idler gears when breaking out joints or collars where high torques are required.*

b) *When making-up integral (shouldered) joints, it is essential to make up the last turn of the threads in low gear. This reduces the tendency of an instant stop or a sudden increase in torque, which induces extremely high stresses on the gear train.*

c) *DO NOT employ the "snap break" method of breaking-out joints when pulling a string. By definition, the "snap break" method is a procedure used by some operators to break out connections, accomplished by leaving slack in the "jaw-pipe" engagement, and then quickly pulling the throttle valve control lever allowing the tong to snap into its loaded or high torque condition. Although this method is very effective in breaking out joints, the extremely high stress placed on the gear train frequently causes gear breakage.*

H. MAKING AND BREAKING CONNECTIONS

THESE OPERATING PROCEDURE ASSUMES THE USER HAS PROPERLY SET UP AND PREPARED THE EQUIPMENT FOR OPERATION AS PER SECTIONS 2D, 2E, AND 2F OF THIS MANUAL.

THESE OPERATING PROCEDURES REFER TO A BACKUP-READY LW9625 TONG, BUT DO NOT INCLUDE OPERATING A BACKUP AS PART OF THE INSTRUCTIONS. FOR INSTRUCTIONS ON MAKING UP A JOINT WITH A TONG & BACKUP REFER TO THE APPROPRIATE TECHNICAL MANUAL FOR YOUR BACKUP-EQUIPPED ASSEMBLY

THE CONFIGURATION OF THE CONTROL VALVES ON YOUR TONG MAY NOT BE EXACTLY AS ILLUSTRATED ON BACKUP-READY TONG IN THE FOLLOWING PROCEDURES.

Set up and prepare your equipment for operation as per Section 2 of this manual Refer to the following sections:

- *2.D - Hydraulic Connections*
- *2.E - Tong Jaw Installation*
- *2.F.1 - Tong Rig-up and Leveling (Suspension)*
- *2.F.2 - Tong Rig-up and Leveling (Leveling)*

Your tong and backup assembly should be properly suspended, connected to a hydraulic power source, and ready to make or break connections at this point.

1. Making A Connection

a) *Ensure hydraulic power supply to the tong is energized. The master link on the rigid sling must be used to suspend the tong. Do not suspend the tong directly from the rigid sling.*

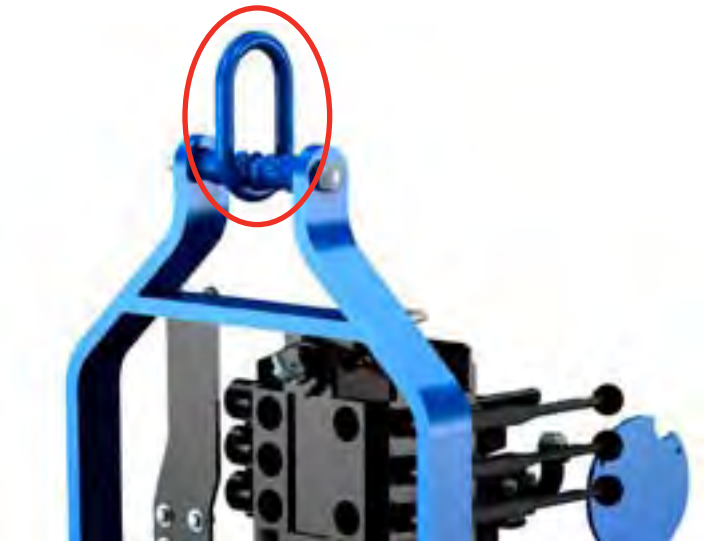

ILLUSTRATION 2.H.1: TONG MASTER LINK

THE MASTER LINK MUST BE USED TO SUSPEND THE TONG ASSEMBLY

Making A Connection (Continued)

b) *Ensure the backing pin is in the "makeup" position. From the front of the tong, the backing pin correctly configured for makeup will be in the 10 o'clock position. If it is not, simply lift up and place in the correct position (see Illustration 2 next page). The cage plate opening must be aligned with the door opening when setting the backing pin position.*

ILLUSTRATION 2.H.2: SETTING BACKING PIN TO "MAKE-UP" POSITION

c) *Ensure the load cell and snub line(s) are properly configured for making up connections. The "snub line" is a length of wire rope or chain that connects the rear of the tong body to a sturdy anchor on the drill floor (see Section 2.F.1). The snub line(s) prevents uncontrolled rotation of the tong when torque begins to build in the joint. The snub line(s) must be rated for the applied torque plus whatever safety margins stated by your own operating policies. The snub line connection point(s) on the drill floor must be sturdy enough to absorb all applied forces when making up the joints. When making up joints the snub line with load cell is attached to the driller's side of the tong, which is the left side of the tong as seen from the rear. Accurate torque measurement is only possible when the load cell is perpendicular to the vertical, and perpendicular to the centre-line of the tong.*

d) *Actuate the lift cylinder control valve (if equipped) to lift the assembly from the drill floor. Push the valve toward the center of the tong to retract the lift cylinder and lift the assembly (see Illustration 2.H.3 below). Note that rig personnel are required to stabilize the tong and backup as it is being lifted so it does not swing and collide with other rig equipment.*

RIG PERSONNEL MUST STABILIZE THE TONG AS IT IS LIFTED FROM THE DRILL FLOOR

ILLUSTRATION 2.H.3: LIFT CYLINDER CONTROL - RAISE

Making A Connection (Continued)

e) *Squeeze the latch handle toward the tong door handle and pull the LH (latch) door open, followed by the RH door. (See Illustration 2.H.4). Since your equipment is equipped with a safety door, opening the door will inhibit rotation of the cage plate.*

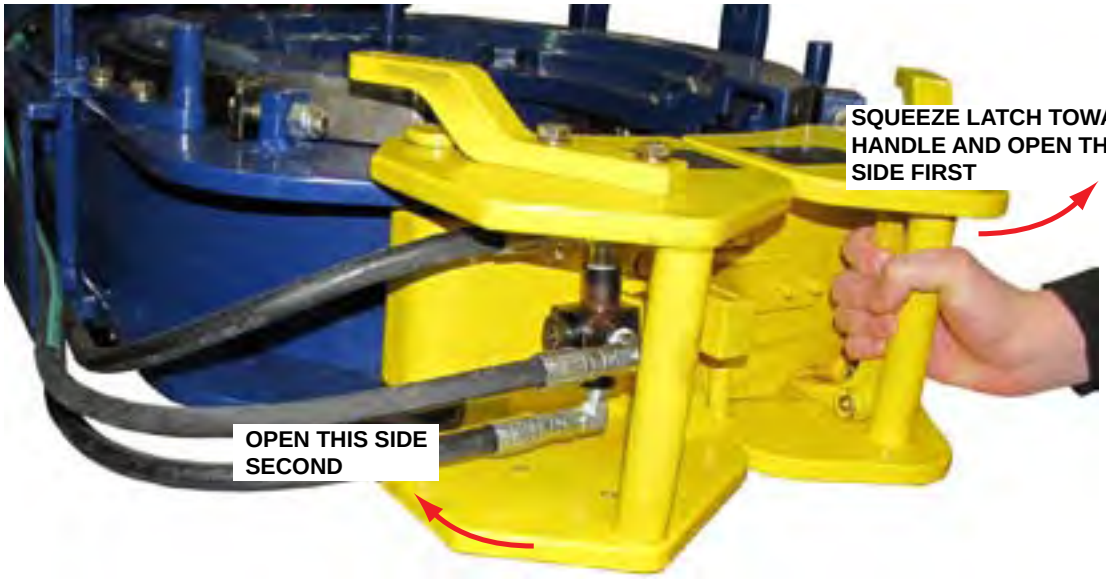

ILLUSTRATION 2.H.4: OPENING TONG DOOR

f) *Manually engage the threads of the tubing connection being made up. Ensure threads are not cross-threaded.*

g) *Move the tong on to the tubing joint. Use the lift cylinder (if equipped) to ensure the tong jaws are at the correct location above the connection joint.*

h) *Firmly close the tong doors - close the RH door first, followed by the LH door. Tug on the door handle to ensure door is latched.*

i) *Ensure tubing is roughly centered within the tong jaws - rig personnel are required to stabilize the tong above the connection until the jaws have been cammed on to the pipe or casing.*

j) *Begin rotation with the tong in high gear (lowest torque). See Section 2.G.3 to properly set the tong to high gear. Do not shift gears while the tong is rotating.*

SHIFTING TONG WHILE ROTATING THE MOTOR AND CAGE PLATE MAY RESULT IN CATASTROPHIC GEAR TRAIN FAILURE

k) *Push the motor control valve toward the tong to rotate the cage plate in the make-up direction.*

ILLUSTRATION 2.H.5: MOTOR CONTROL - MAKE-UP

Making A Connection (Continued)

l) When the tong jaws cam on to the tubing push the rotation control handle all the way in to thread the connection together at high speed. As the joint becomes fully made up the increasing torque demand will stall the motor, and displayed torque will increase (if using a torque measurement system).

m) Stop rotation, and shift to low gear (highest torque - See Section 2.G.3 for shifting to low gear). This will enable the tong to produce adequate torque for making up the joint to specification.

n) Push the rotation control handle all the way in to complete the connection at low speed/high torque. Observe the torque gauge - when the specified make-up torque is reached stop rotation. Reverse the rotation control valve to release the tong jaws from the tubing (see Illustration 2.H.6 next page).

ILLUSTRATION 2.H.6: MOTOR CONTROL - RELEASING JAWS

o) When tong jaws are free align the cage plate with the tong opening, and open the tong doors to free the tong from the drill string. Note that rig personnel may be required to stabilize the tong as it completely releases from the drill string. Guide the tong away from the string and use the lift cylinder control (if equipped) to lower it to the drill floor if desired.

ILLUSTRATION 2.H.7: LIFT CYLINDER CONTROL - LOWER

p) Repeat steps "f" through "o" until the desired number of connections are made up.

2. Breaking A Connection

YOUR TONG SHOULD BE PROPERLY SUSPENDED, CONNECTED TO A HYDRAULIC POWER SOURCE, AND READY TO BREAK CONNECTIONS.

a) *Ensure hydraulic power supply to the tong and backup is energized. The master link on the rigid sling must be used to suspend the tong. Do not suspend the tong directly from the rigid sling. See Illustration 2.H.1.*

b) *Set the backing pin for "breakout" operation. Lift up on the backing pin and rotate it to the "breakout" position, which is 2 o'clock as seen from the front of the tong. The opening in the rotary gear must be aligned with the tong door opening in order to properly set the backing pin (see Illustration 2.H.8 next page).*

ILLUSTRATION 2.H.8: SETTING BACKING PIN TO "BREAK-OUT" POSITION

c) *If torque measurement is required for break-out operations the load cell must be transferred to the snub line on the off-driller's side (the right hand side as seen from the rear of the tong) to perform torque measurement during break-out operations.*

d) *Open the tong door (see Illustration 2.H.4).*

e) *Actuate the lift cylinder control valve (if equipped) to lift the assembly from the drill floor if necessary. Pushing the valve toward the center of the tong will retract the lift cylinder to lift the assembly (see illustration 2.H.3). Note that rig personnel are required to stabilize the tong and backup as it is being lifted so it does not swing and collide with other rig equipment.*

RIG PERSONNEL MUST STABILIZE THE TONG AS IT IS LIFTED FROM THE DRILL FLOOR

f) *Move the tong on to the tubing joint. Use the lift cylinder to ensure the tong jaws are at the correct location above the connection joint.*

g) *Firmly close the tong door against the latch post.*

h) *Ensure tubing is roughly centered within the tong jaws - rig personnel are required to stabilize the tong above the connection until the jaws have been cammed on to the pipe or casing.*

i) *Breakout torque is only available when tong is in low gear. See Section 2.G.3 to shift to low gear. Do not shift gears while the tong is rotating.*

SHIFTING TONG WHILE ROTATING THE MOTOR AND CAGE PLATE MAY RESULT IN CATASTROPHIC GEAR TRAIN FAILURE

Breaking A Connection (Continued)

j) Breakout torque is only available in the low-speed mode. If the motor speed control is not already in the "low speed" position grasp the motor speed control valve and firmly push down until it "latches" into its detent position. Gently pull the rotation control valve toward the operator to slowly rotate the cage plate until the tong jaws cam on to the tubing.

k) Pull the motor control valve toward the operator to rotate the cage plate in the break-out direction.

ILLUSTRATION 2.H.9: ROTATION CONTROL - BREAK-OUT

l) When the tong jaws cam on to the tubing pull the rotation control handle all the way out to break the connection.

m) When the connection breaks stop rotation and shift to high gear (see 2.G.3 to shift to high gear). This will enable the tong to completely un-thread the connection at high speed.

n) Pull the rotation control handle all the way out to completely un-thread the connection. Reverse the rotation control handle (push toward tong) to release the tong jaws from the tubing.

ILLUSTRATION 2.H.10: RELEASING TONG JAWS FOLLOWING BREAK-OUT & UN-THREADING

Breaking A Connection (Continued)

o) Align the cage plate with the tong opening. Unlatch and open the tong door to free the assembly from the tubing. Note that rig personnel may be required to stabilize the equipment as it completely releases from the tubing. Guide the assembly away from the string and use the lift cylinder control (if equipped) to lower it to the drill floor if desired.

ILLUSTRATION 2.H.11: LOWERING TONG USING LIFT CYLINDER CONTROL

p) Use your rig's standard pipe handling procedures to remove and rack the freed tubing stand.

q) Repeat steps "e" through "p" as many times as necessary to break out and un-thread the desired number of connections.

H. EXTREME COLD WEATHER OPERATION PROCEDURES

1) Consult the power unit engine operator's manual for all cold weather operating procedures and precautions.

2) Select gear and bearing lubricants that are compatible with expected climatic conditions.

3) Select hydraulic fluid that is compatible with expected climatic conditions.

4) Allow hydraulic fluid to circulate for approximately 20 minutes after starting the power unit, prior to activating the bypass valve to allow fluid to circulate to tong. If the power unit is equipped with an oil temperature gauge, ensure that the fluid has reached operating temperature as specified by hydraulic fluid data sheet.

5) Allow for adequate drying of moisture (prior to lubricating) when cleaning tong parts in cold weather.

McCoy Completions & Drilling recognizes that minor on-site repairs and modifications are required to maintain peak operating condition of your equipment, or to match your equipment with the operating environment. Examples of minor repairs are

- *replacement of damaged hydraulic hoses and fittings.*
- *replacement of malfunctioning pressure gauges and valves.*
- *replacement of door cylinders*
- *replacement of fasteners*

Any replaced component must be an identical component supplied by McCoy Completions & Drilling. Replaced fasteners must be Grade 8 or equivalent, or whatever fastener is specified by McCoy.

A. GENERAL MAINTENANCE SAFETY PRACTICES

The practices identified here are intended as a guideline. All personnel are responsible for performing their tasks in a manner that ensures worker, equipment, and environmental safety, and may require taking additional steps that are not identified in this section.

Equipment maintenance shall be performed only by designated qualified maintenance personnel. Wear approved eyewear and footwear, and follow all of your company's safety guidelines Do not begin a maintenance task without the proper tools or materials on hand, or the proper drawings and documentation necessary.

Schedule planned maintenance with operators to avoid conflicts, unnecessary downtime, and the danger of accidental equipment activation. Notify operations when maintenance procedures are complete and equipment functionality is restored.

Isolate the location of the maintenance under way to prevent unaware personnel from inadvertently exposing themselves to a hazard. Use tape, rope, or signs to clearly indicate "off-limits" area.

Replacement of large, heavy individual parts and/or heavy structural components must be performed using an approved lifting device of sufficient lifting capacity. Use care when attaching the lifting device, and safeguard area to avoid endangering personnel or equipment.

All spare parts must meet or exceed OEM specifications in order to maintain equipment integrity, especially protective equipment

McCoy recommends that disconnection of hydraulic connectors be performed with the power unit off and the hydraulic circuit depressurized.

Your equipment uses materials that may be harmful to the environment if improperly disposed of (hydraulic fluid, grease, etc.). Dispose of all materials according to your company's proscribed environmental protection regulations.

B. CLEANING

Clean tong thoroughly cleaned with a good petroleum-based cleaning agent after each job, prior to storage. Farr recommends that the motor and valve assembly be periodically removed, along with the top tong plate, so that guides, rollers and gears can be properly cleaned. Ensure that cleaning solvents and chemicals are captured to prevent environmental contamination, and dispose of all materials according to your company's proscribed environmental protection regulations.

C. PREVENTIVE MAINTENANCE

Regular maintenance programs are necessary, and must be established to assure safe, dependable operation of your Hydraulic Tubular Connection System and to avoid costly breakdown maintenance. The following maintenance procedures provides information required to properly maintain your equipment. Your equipment may require more, or less maintenance depending upon the frequency of use and the field conditions under which your equipment operates. These maintenance procedures are designed for equipment operating at 10°C to 35°C ambient temperature for 10 hours per day. McCoy recommends that the inspection and maintenance procedures in this section be performed as recommended in the maintenance checklists (see Appendices), or in conjunction with your maintenance foreman's experience and best estimate of when your equipment is due for this maintenance.

Purchased components included with your hydraulic tubular connection equipment (for example: motors, valves, etc.) may specify maintenance tasks and intervals over and above what McCoy recommends as part of their recommended procedures. Users of this equipment may choose to perform or ignore these additional tasks at their discretion.

Premature fouling of particulate filters within your prime mover or ancillary hydraulic power unit requires immediate hydraulic fluid laboratory analysis to prevent premature wear of hydraulic system due to high levels of wear metals in the fluid.

McCoy Completions & Drilling recommends tracking all maintenance activity including the lubrication schedule. This may be a simple as keeping a paper log, or using a software-based maintenance tracking utility. A maintenance log is a valuable tool that can be used for easily retrieving maintenance history or identifying trends that require correction.

D. LUBRICATION

Use a quality multipurpose bearing lubricant that will remain within its viscosity range at expected operating temperatures. In addition, Farr recommends the following lubrication procedure at the completion of each job prior to storage.

1. Cage Plate Cam Followers

The cage plate cam followers are sealed units, and do not require lubrication. However, the cage plate and rotary gear grooves in which the cam followers ride should be lightly greased. When the cage plate is rotated as a unit, the cam followers are exposed, and can be greased. Continue rotating the cage plate assembly until all cam followers, top and bottom, are greased (see illustration 3.D.1).

ILLUSTRATION 3.D.1: CAGE PLATE / CAM FOLLOWER LUBRICATION

2. **Rotary Idler Bearings**

Apply grease to these bearings through the grease fittings in the ends of the rotary idler shafts, located on the top of the tong to the inside of each rigid sling weldment (2 locations total).

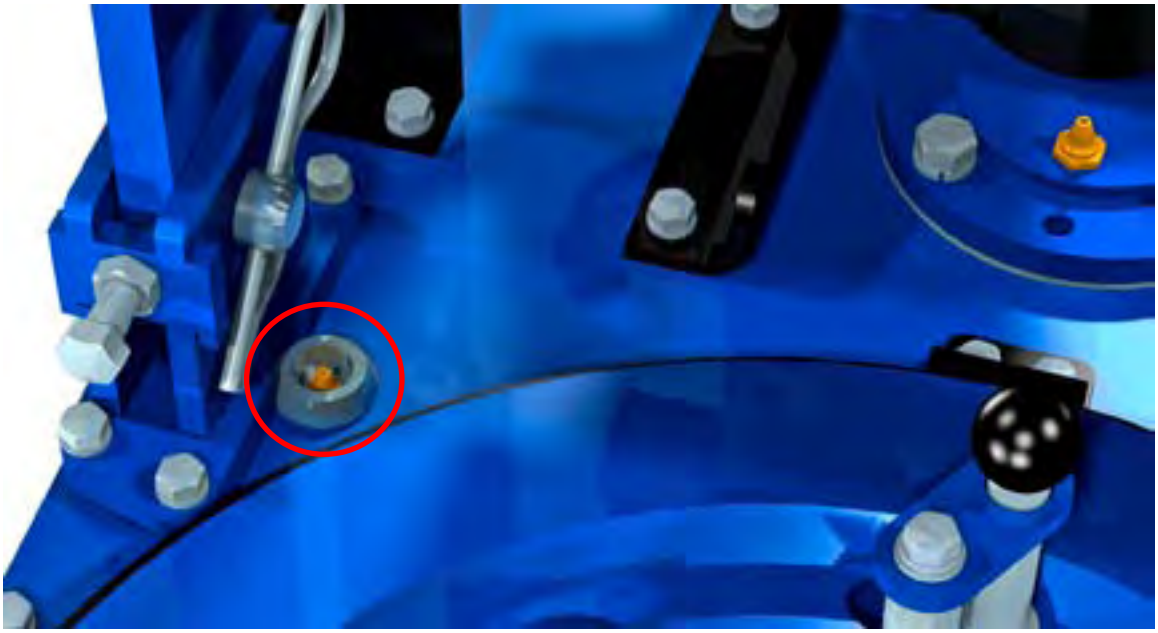

ILLUSTRATION 3.D.2: ROTARY IDLER LUBRICATION

3. **Pinion Idler Bearings**

Apply grease to these bearings through the grease fittings in the ends of the pinion idler shafts, located on the bottom of the tong on each side of the stiffener plate, just behind the brake band (2 locations total).

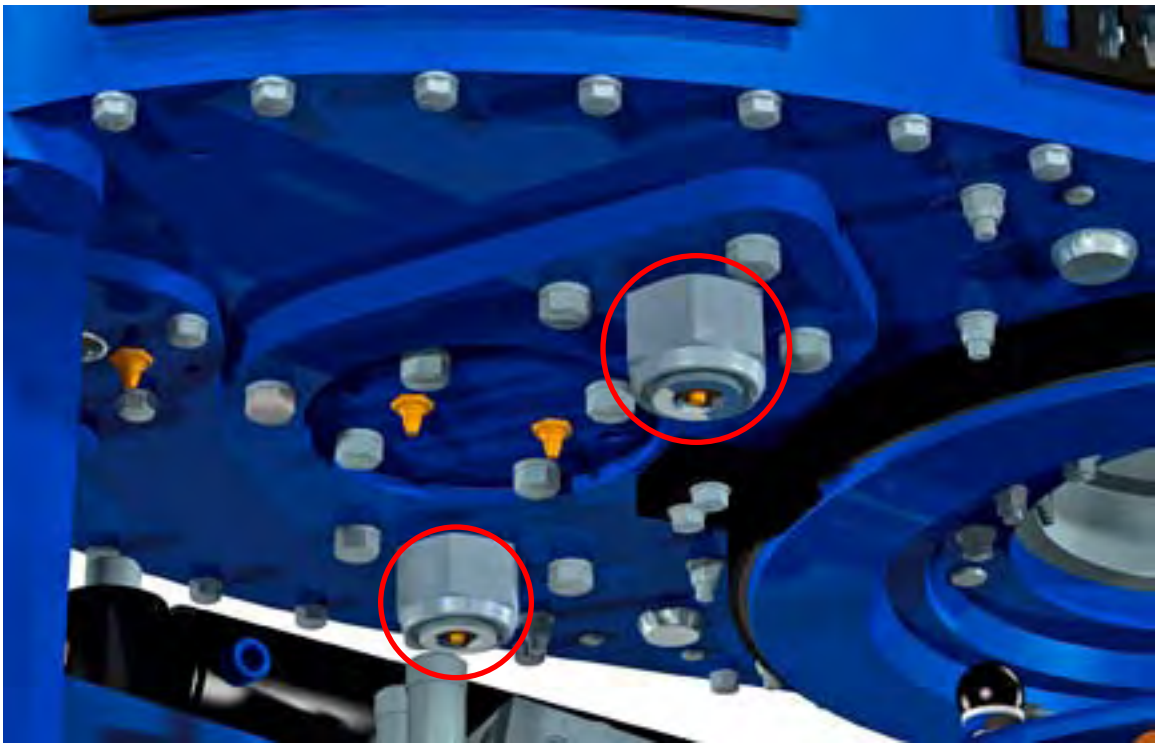

ILLUSTRATION 3.D.3: PINION IDLER LUBRICATION

4. Pinion Bearings

Apply grease to these bearings through the grease fittings in the pinion bearing caps located on the top of the tong directly beneath the valve bank, and on bottom of the tong in the center of the stiffener plate (total of four locations).

ILLUSTRATION 3.D.4: PINION LUBRICATION (TOP PLATE)

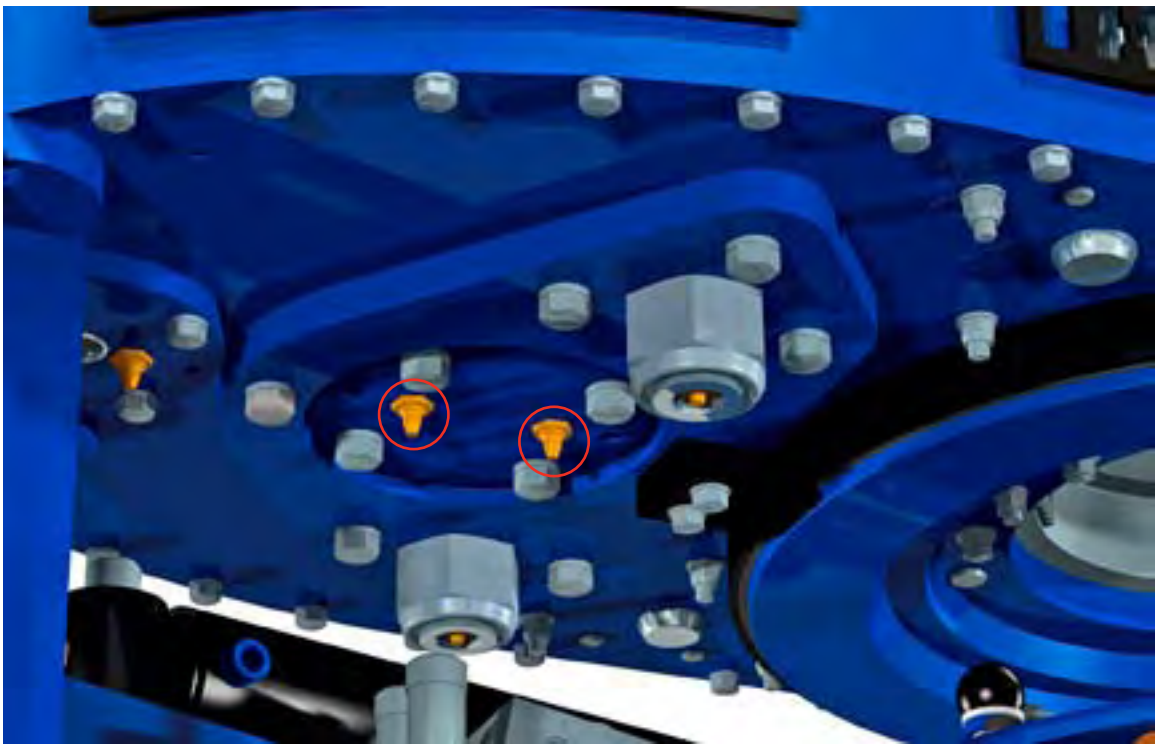

ILLUSTRATION 3.D.5: PINION LUBRICATION (BOTTOM PLATE)

5. ***Clutch Shaft Bearings***

Apply grease to these bearings through three grease fittings in the clutch bearing cap, which is located on the bottom plate. Note that the centre grease fitting is recessed into the end of the clutch shaft.

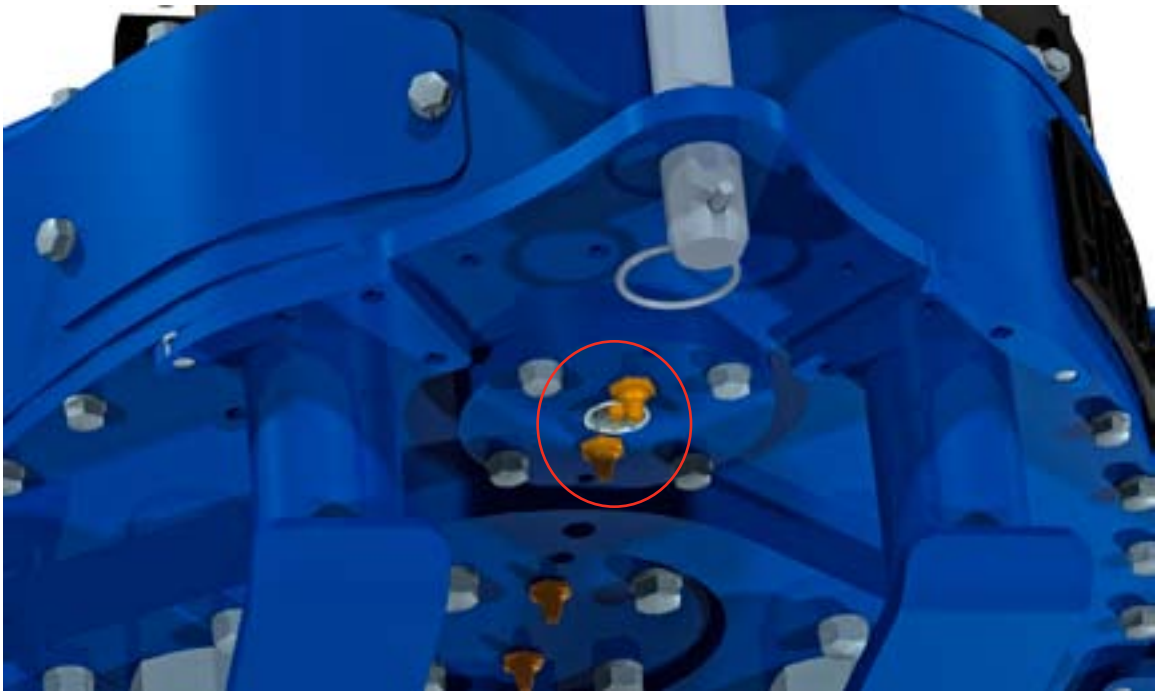

ILLUSTRATION 3.D.6: CLUTCH LUBRICATION

6. ***Motor Mount Housing***

Apply grease to the gears in this housing through the two grease fittings on the bearing cap on top of the motor mount, in the area indicated by the red circle.

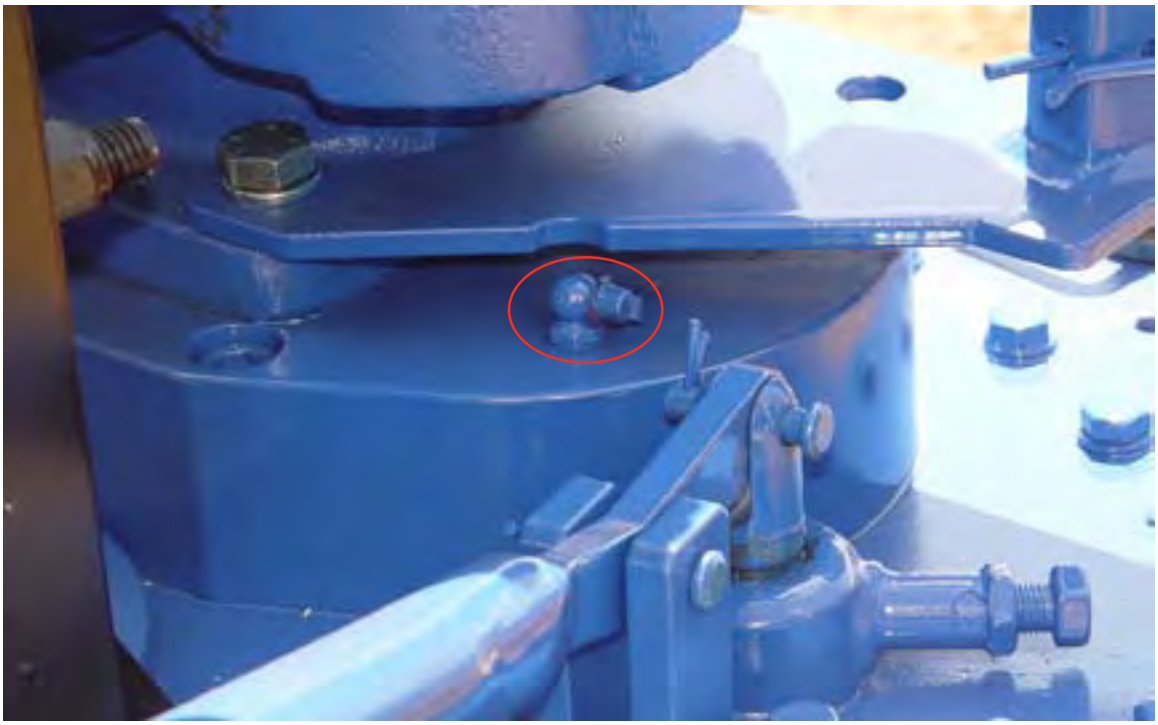

ILLUSTRATION 3.D.7: MOTOR MOUNT LUBRICATION

7. ***Shifting Shaft***

Apply grease to the shifting shaft and shifting shaft bushings. These can be accessed through the cover plate on the side of the tong, near the rear.

ILLUSTRATION 3.D.8: SHIFTING SHAFT / GEAR TRAIN LUBRICATION ACCESS PANEL

9. ***Door Latch & Door Stops***

Apply a small amount of grease to the door latch claws, post, and stops as necessary in order to maintain smooth operation.

10. ***Door Spring Cylinders***

Periodically disassemble the door stop cylinders and coat the spring and cylinder with a general purpose lubricating oil.

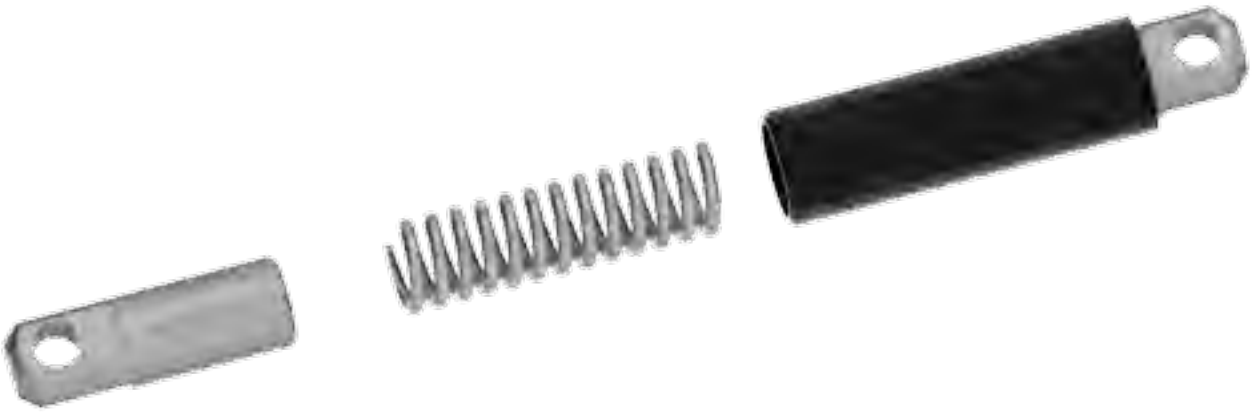

ILLUSTRATION 3.D.9: DOOR STOP CYLINDER (EXPLODED)

E. ADJUSTMENTS

1. Brake Band Adjustment (See illustration 3.E.1):

The brake bands must be periodically adjusted to continue to provide smooth and efficient jaw cam action. If the cage plate turns with the rotary gear, the jaws will not cam properly and, therefore, will not bite on the tubing or casing. Tightening the brake band against the cage plates will increase frictional resistance, allowing jaws to cam properly and grip the casing. Adjust the brake band using the adjustment nut and bolt set as shown in the illustration below. Do not over tighten, as this causes excessive wear to the brake bands.

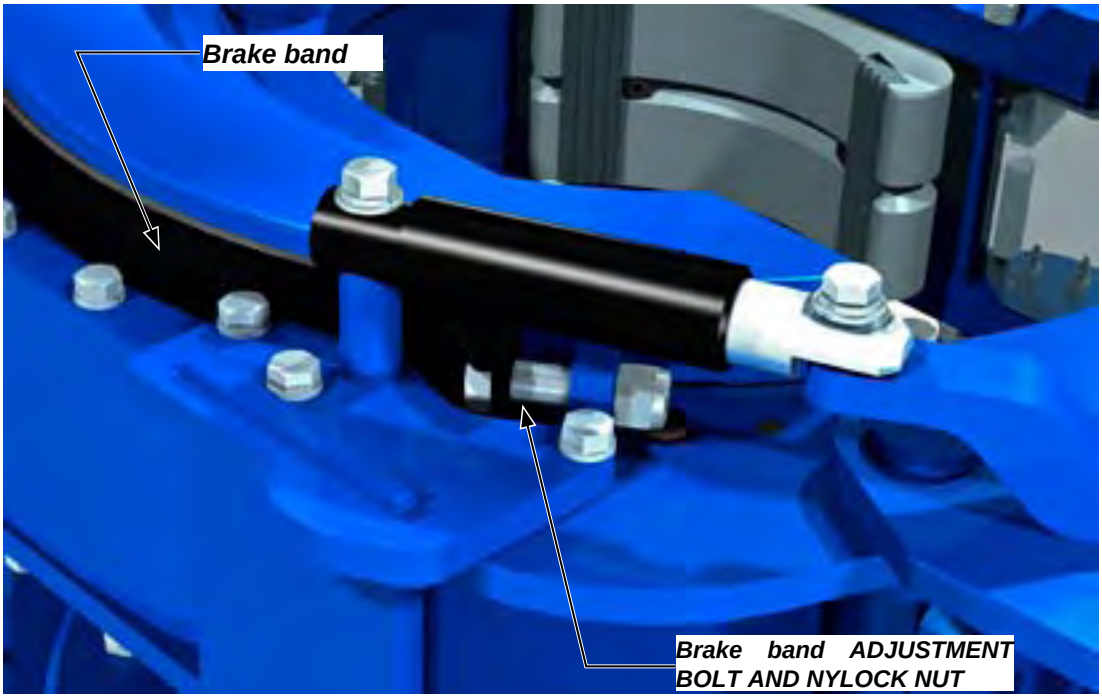

ILLUSTRATION 3.E.1: BRAKE BAND ADJUSTMENT

2. Shifter Detent Adjustment

Over time wear to the shifting shaft, wear to the detent ball, and loss of spring tension in the detent spring may result in a loose or "sloppy" fit within the top shifter bushing. The detent pressure may be increased or otherwise adjusted by loosening the 7/16" UNF locking jam nut, and turning the 7/16" UNF detent bolt. Should adequate detent action not be achieved, the shifting shaft, detent ball, or detent spring (or possibly all three) may need to be replaced (see Pp. 5.12 - 5.13).

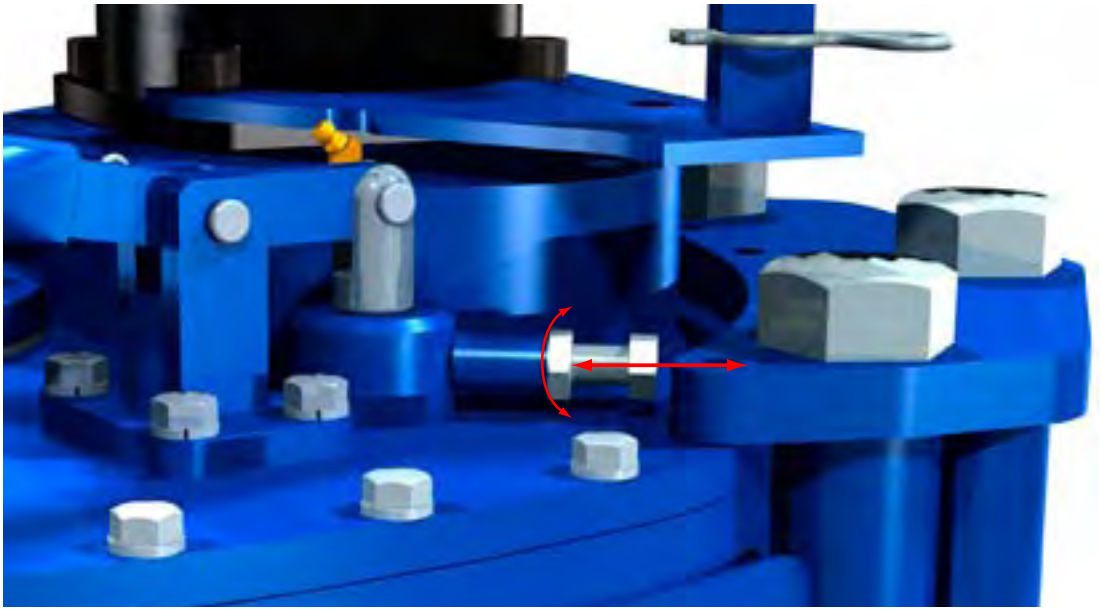

ILLUSTRATION 3.E.2: SHIFTER DETENT FORCE ADJUSTMENT

3. Safety Door Switch Adjustment

The safety door switch should interrupt hydraulic power to the motor when the tong door is opened, or even slightly ajar. This is a critical safety system, and proper adjustment is necessary to maintain the intended function. If the rotary gear does not immediately and completely stop rotating when the door is opened, remove the tong from service and perform the following adjustments:

a. *Set the tong up in a controlled testing environment without connecting hydraulic power.*

b. *Open the tong door and check operation of the safety door switch plunger. Depress and allow it spring back several times to ensure smooth operation. If the plunger binds or jams, remove the control cable guide mount at the door end, remove the control cable and plunger, and thoroughly clean and lubricate the plunger and control cable before reinstalling.*

c. *Test the control cable after cleaning and reinstallation. The cable end should spring back when depressed. If the cable does not smoothly spring back, replace the control cable.*

d. *Following reinstallation the plunger should extend 1/4 of an inch from the end of the control cable guide mount.*

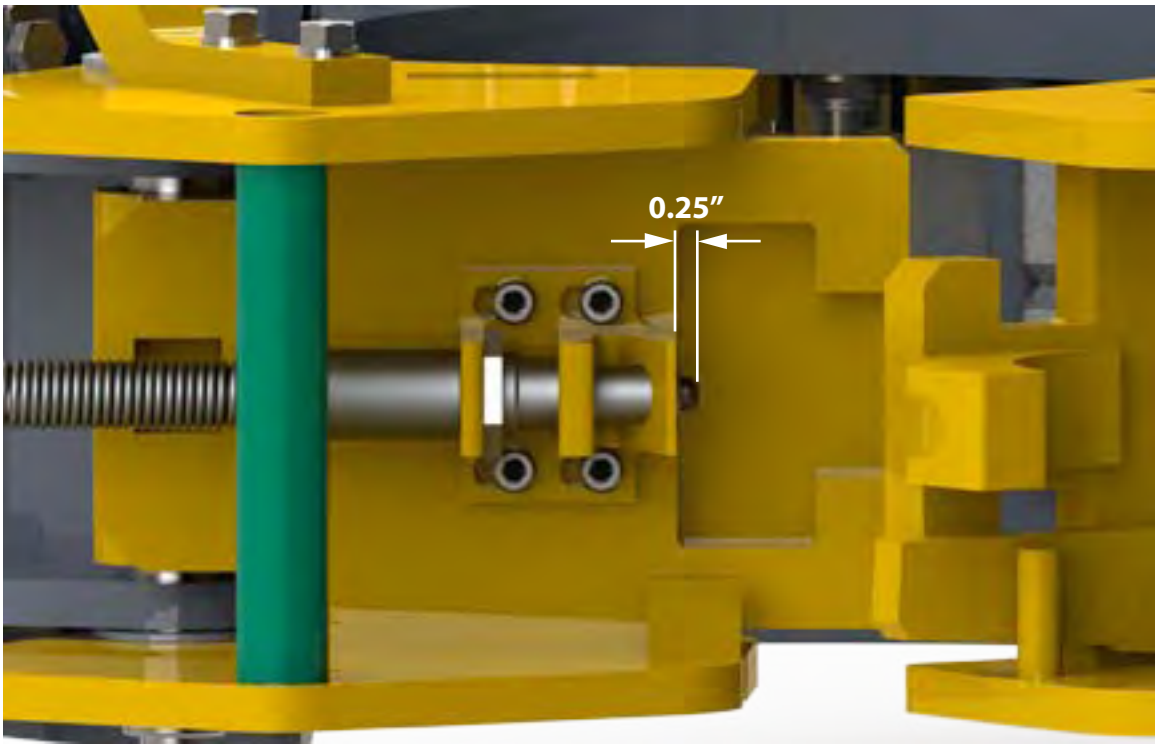

ILLUSTRATION 3.E.3: SAFETY DOOR ADJUSTMENT 01

e. *Connect hydraulic power to the tong.*

f. *Ensure the door is closed and all personnel are clear. Begin rotating the cage plate. Open the tong door - the cage plate should immediately and completely stop.*

g. *Release all controls, and close the tong door again. Ensure the cage plate rotates with the door closed.*

h. *If cage plate continues to rotate with the door open, adjustment of the position of the plunger on the safety door switch is necessary. Remove hydraulic power from the tong.*

j. *Loosen the 15/16" valve lock nut securing the cable guide tube, and remove the cable guide tube from the mounting block.*

k. *Loosen the jam nut locking the position of the push-pull cable inside the cable guide tube. Rotate the cable guide tube one revolution CLOCKWISE, causing the plunger to extend slightly further from the end of the guide tube. NOTE: Only small adjustments are necessary - adjust the mounting tube only one revolution at a time between functional tests of the safety door. Secure the cable guide tube with the jam nut after each adjustment.*

Safety Door Switch Adjustment (continued):

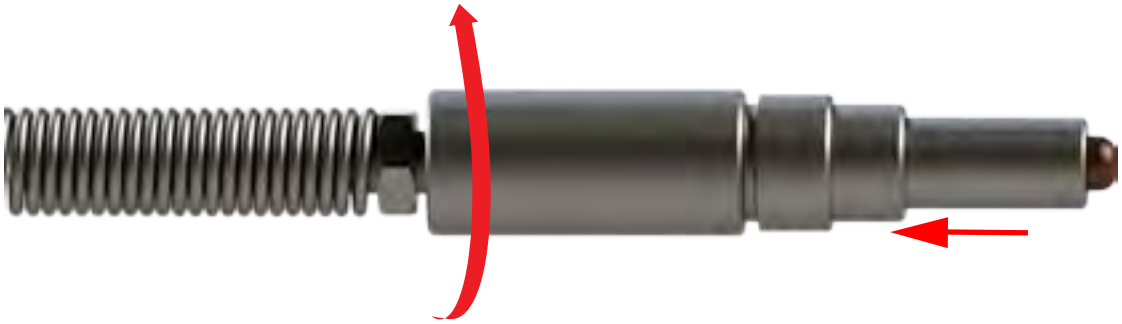

ILLUSTRATION 3.E.4: SAFETY DOOR ADJUSTMENT 02

l. Re-install the push-pull cable guide tube in to the mounting block and secure with the 15/16" valve lock nut.

m. Connect hydraulic power to the tong.

n. Ensure the door is closed and all personnel are clear. Begin rotating the cage plate. Open the tong door - the cage plate should immediately and completely stop.

o. Release all controls, and close the tong door again. Ensure the cage plate rotates with the door closed.

p. If cage plate continues to rotate with the door open, further adjustment of the safety door switch is necessary. Remove hydraulic power from the tong.

q. Repeat steps "h" through "n" as many times as necessary to properly adjust the safety door mechanism. Once the adjustments are satisfactorily complete the tong may be returned to service.

F. RECOMMENDED PERIODIC CHECKS

1. Door Stop Springs

The springs inside the actuator cylinders must be of sufficient strength to enable the door latch mechanisms to snap closed properly. Door stop spring fatigue will result in sluggish latch operation. Replace the latch springs inside the cylinders when this occurs.

2. Backing Pin

Perform a visual inspection of the backing pin after each job. Replace the pin if stress cracks or excessive wear is found, or if either pin is bent.

3. Shifting Shaft

The shifting yoke is secured to the shifting shaft by one hex jam nut above the shifting yoke, and one locknut on the bottom of the yoke. Check these nuts after each job. Do this by removing the clutch inspection plate and ensuring a snug fit prior to lubrication.

4. Torque Gauge Assembly

Periodic calibration of the torque gauge is recommended to assure accurate torque readings. When having the torque gauge serviced and calibrated, it is critical to note the arm length of the tong, as indicated in the "Specifications" section. Farr recommends that the torque gauge assembly be calibrated yearly.

G. OVERHAUL PROCEDURES

The tong may be overhauled following the disassembly instructions in the following procedure. Access to the gear train is possible by removing the top plate of the tong.

ALL MAINTENANCE AND OVERHAUL SHOULD BE PERFORMED FROM THE TOP. THEREFORE, THE BOTTOM PLATE OF THE TONG SHOULD NEVER BE REMOVED FROM THE GEAR CASE HOUSING.

ANY REPLACEMENT FASTENER (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT.

REMOVAL OF TOP PLATE

1. *Place the tong on a suitable surface that will support the entire weight of the tong and allow access to the bottom of the tong.*
2. *Support the rigid sling with a crane. Remove the two hitch pins from each rigid sling pin, and remove the rid sling pins. The rigid sling may now be lifted away from the tong. Remove both rigid sling hanger bracket weldments - note that the two inside fasteners on each hanger are long bolts that run down through body spacers and are secured on the bottom plate with nylock nuts.*
3. *Disconnect the hydraulic connections from the motor. Undo the restraints securing the inlet and outlet lines from their supports, and the four 3/8" x 1" bolts securing the valve mount weldment to the top plate. Lift the entire hydraulic valve section away from the tong. Remove the inlet and outlet support pieces.*
4. *Remove the adjustable outlet support from the top plate.*
5. *Remove the two tong door stop cylinders. Remove the Z-shaped door cylinder mounting brackets from the top of each door assembly.*
6. *Remove each door assembly by removing the door pins. Remove the 1" outside snap ring from the bottom of each door pin. Support each door assembly as the door pin is removed - a soft alloy material (e.g. brass rod, etc.) may be required to lightly tap the shaft up through the door assembly until it comes free at the top.*

NOTE: If your tong is equipped with the safety door system you may leave the safety door switch components in place on the door assemblies.

7. *Remove the two socket head cap screws securing the torque gauge mount, and lift the gauge mount out of place.*
8. *Remove the remaining two socket head cap screws securing the motor, and lift the motor off the motor mount. Inspect the motor gear, located at the bottom of the motor shaft, for gear clashing or tooth damage. Also, ensure that the motor gear is securely attached to the motor shaft.*
9. *Remove the motor mount by removing the four socket head cap screws. The motor mount can be lifted out of place. Take care not to lose the two position dowels - one, or both, may come off with the mount.*
10. *Remove the snap ring that secures the clutch drive gear. Remove the clutch drive gear and top clutch spacer. Remove the six #10 x 3/4" socket head cap screws securing the bearing retainer to the top plate, and slide the bearing and bearing retainer up and off the clutch shaft.*
11. *Remove the clevis pin connecting the shifting shaft handle to the shifting shaft. Back off the shifter position detent spring and ball assembly as much as possible without removing the detent assembly.*
12. *Remove the access panel on the body side adjacent to shifter assembly. Remove the 5/8" fine thread nut, and 5/8" fine thread jam nut from the shifting shaft to release the shifting fork from the shaft. The shifting shaft may now be carefully rotated and pulled out of the top shifter bushing. Use caution that the shifter detent ball is not dislodged and lost when the shifter shaft is removed.*
13. *Remove the four 3/8" x 1" hex bolts and 3/8" lock washers securing the shifter lug weldment to the top plate, and remove the shifter lug and the shifter handle.*
14. *Remove the top brake band by removing the rear brake band retainer (secured with two 3/8" x 1" bolts and 3/8" lock washer), and the adjustment bolts and nuts near the front leg mounts.*
15. *Remove the bottom brake band by removing the rear brake band retainer (secured to the bottom stiffener plate with two 3/8" x 1-1/4" bolts and 3/8" lock washer), and the adjustment bolts and nuts near the front leg mounts.*
16. *Remove the two front leg mount weldments.*
17. *If not already done, remove the jaw pivot bolts and the jaw assemblies.*
18. *Remove the backing pin assembly, but leave the rear cage plate bolt in place.*

REMOVAL OF TOP PLATE Cont'd:

THE CAGE PLATE BOLTS ARE THE ONLY ITEMS FASTENING THE BOTTOM CAGE PLATE TO THE TONG. SUPPORT THE BOTTOM CAGE PLATE FROM BELOW PRIOR TO REMOVING CAGE PLATE BOLTS IN ORDER TO PREVENT DAMAGE TO THE BOTTOM CAGE PLATE OR PERSONAL INJURY TO THE MECHANIC

19. *Remove the upper and lower nuts and washers from the front cage plate spacers, Remove the three rear cage plate bolts, washers, and nuts, and the rear cage plate spacer. The cage plates may now be removed.*
20. *Pull the top bearing cap and spacer for the pinion drive gear by removing the four 1/2" bolts which secure the bearing cap to the top plate. Thread two of the removed bolts into the extra holes on top of the bearing cap, and use them as lifting lugs to lift the bearing cap out of place.*

IF THE BEARING REMAINS ATTACHED TO THE GEAR SHAFT AFTER THE BEARING CAP IS PULLED, FARR SERVICE PERSONNEL RECOMMENDS LEAVING IT IN PLACE UNTIL THE TOP TONG PLATE IS REMOVED.

21. *Remove the two 3/8" x 6" hex bolts that run down through the remaining body spacers - these are secured on the bottom of the tong with 3/8" nylock nuts.*
22. *Remove the hex head bolts and recessed socket head cap screws around the perimeter of the tong which secure the top plate to the gear case housing.*
23. *With all the above steps taken, the top tong plate can be lifted off providing access to the inside of the gear case. Note that the top cam follower array remains attached to the top plate - these cam followers should all be inspected, and replaced if necessary.*

H. ASSEMBLY PROCEDURES

Assembly of Farr Hydraulic Power Tongs is straightforward, and can be accomplished without the use of special tools. The instructions on this page are presented as a guide only, and are similar to the assembly sequence our technician would use while assembling the tong in our plant.

ALL FASTENERS USED DURING REASSEMBLY OF LOAD-BEARING COMPONENTS (CHAIN SLINGS, RIGID SLINGS, BACKUP LEGS) MUST BE TIGHTENED TO THE CORRECT TORQUE. THREADED FASTENERS USED IN LOAD-BEARING DEVICES MUST BE SECURED WITH RED LOCTITE™.

TIGHTENING TORQUE GUIDE			
SAE GRADE 8 - FINE THREAD			
SIZE	CLAMP LOAD	PLAIN	PLATED
1/4 - 28 (.250)	3,263	14 ft. lbs.	10 ft. lbs.
5/16- 24 (.3125)	5,113	27 ft. lbs.	20 ft. lbs.
3/8 - 24 (.375)	7,875	49 ft. lbs.	37 ft. lbs.
7/16 - 20 (.4375)	10,650	78 ft. lbs.	58 ft. lbs.
1/2 - 20 (.500)	14,400	120 ft. lbs.	90 ft. lbs.
9/16 - 18 (.5625)	18,300	172 ft. lbs.	129 ft. lbs.
5/8" - 18 (.625)	23,025	240 ft. lbs.	180 ft. lbs.
3/4 - 16 (.750)	33,600	420 ft. lbs.	315 ft. lbs.
7/8" - 14 (.875)	45,825	668 ft. lbs.	501 ft. lbs.
1 - 12 (1.000)	59,700	995 ft. lbs.	746 ft. lbs.
1 - 14 (1.000)	61,125	1019 ft. lbs.	764 ft. lbs.
1 1/8 - 12 (1.125)	77,025	1444 ft. lbs.	1083 ft. lbs.
1 1/4 - 12 (1.125)	96,600	2012 ft. lbs.	1509 ft. lbs.
1 3/8 - 12 (1.375)	118,350	2712 ft. lbs.	2034 ft. lbs.
1 1/2 - 12 (1.500)	142,275	3557 ft. lbs.	2668 ft. lbs.
SAE GRADE 8 - COARSE THREAD			
SIZE	CLAMP LOAD	PLAIN	PLATED
1/4 - 20 (.250)	2,850	12 ft. lbs.	9 ft. lbs.
5/16- 18 (.3125)	4,725	25 ft. lbs.	18 ft. lbs.
3/8 - 16 (.375)	6,975	44 ft. lbs.	33 ft. lbs.
7/16 - 14 (.4375)	9,600	70 ft. lbs.	52 ft. lbs.
1/2 - 13 (.500)	12,750	106 ft. lbs.	80 ft. lbs.
9/16 - 12 (.5625)	16,350	153 ft. lbs.	115 ft. lbs.
5/8" - 11 (.625)	20,325	212 ft. lbs.	159 ft. lbs.
3/4 - 10 (.750)	30,075	376 ft. lbs.	282 ft. lbs.
7/8" - 9 (.875)	41,550	606 ft. lbs.	454 ft. lbs.
1 - 8 (1.000)	54,525	909 ft. lbs.	682 ft. lbs.
1 1/8 - 7 (1.125)	68,700	1288 ft. lbs.	966 ft. lbs.
1 1/4 - 7 (1.125)	87,225	1817 ft. lbs.	1363 ft. lbs.
1 3/8 - 6 (1.375)	103,950	2382 ft. lbs.	1787 ft. lbs.
1 1/2 - 6 (1.500)	126,450	3161 ft. lbs.	2371 ft. lbs.

REPLACEMENT FASTENERS MUST BE GRADE 8 OR EQUIVALENT, UNLESS OTHERWISE SPECIFIED BY MCCOY DRILLING & COMPLETIONS.

Assembly Procedures (continued):

NOTE ON INSTALLATION PRACTICES: Ensure all bearings are liberally greased before installing over a shaft or into gears or bearing caps. When inserting a shaft through a support roller assembly ensure shaft is greased. Also ensure all metal-to-metal contact in the gear train is adequately greased. When graphics are not used in the assembly process, please refer to the relevant exploded diagrams in Section 5.

NOTE: THE SIX BODY SPACERS ARE TYPICALLY TACK-WELDED TO THE BOTTOM PLATE AT INITIAL ASSEMBLY IN THE FACTORY. FOR CLARITY PURPOSES THESE SPACERS ARE NOT SHOWN IN THE IMAGES USED IN THE ASSEMBLY GUIDE.

1. *Position the tong body gear case on a suitable stationary support such that the bottom body plate is accessible.*
2. *Install twenty-five cam followers in the bottom plate as shown in the following illustration. Secure each cam follower with a 5/8" lock washer and 5/8" UNF jam nut (See Illustration 3.H.1).*

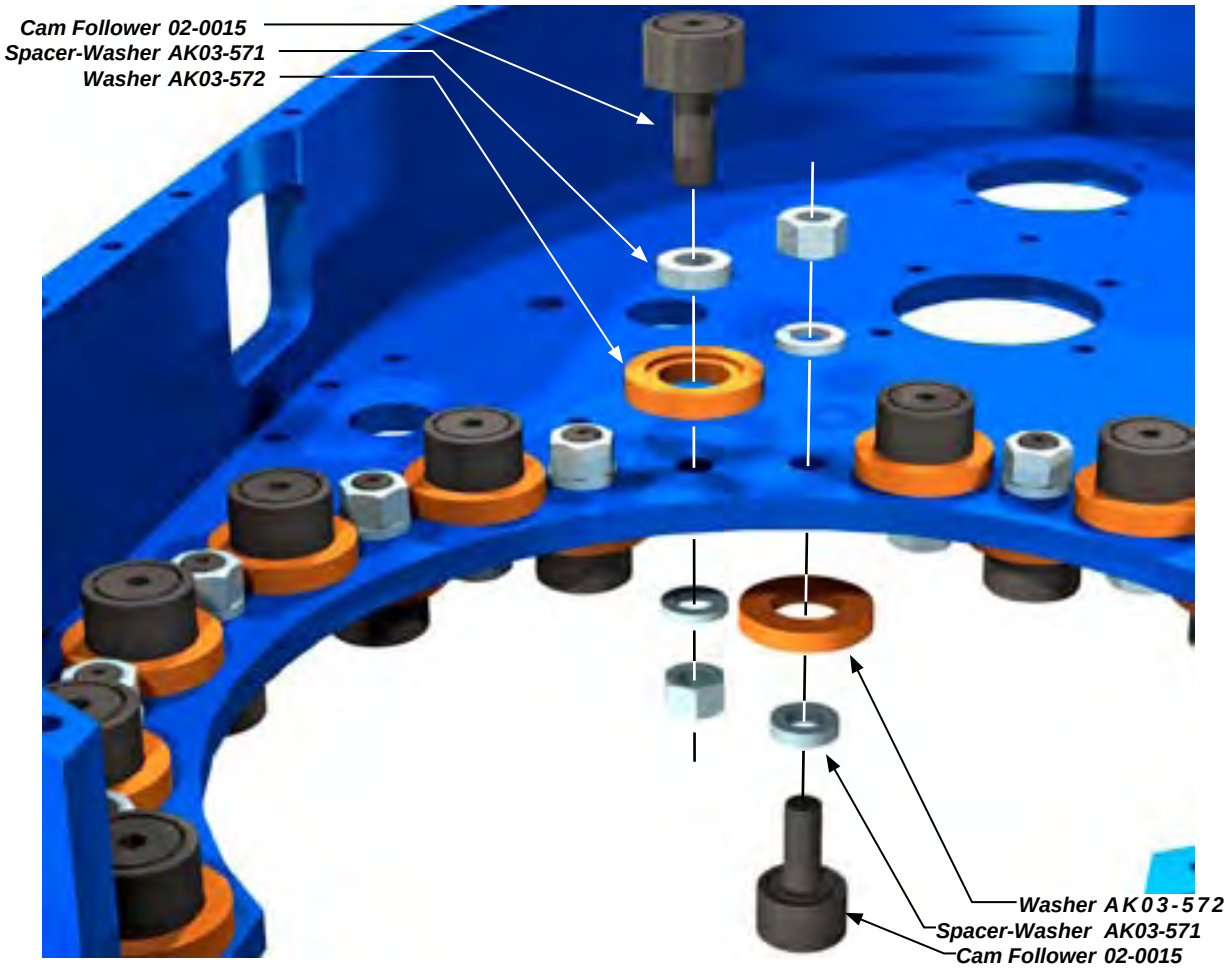

ILLUSTRATION 3.H.1: CAM FOLLOWER INSTALLATION (BOTTOM PLATE)

Assembly Procedures (continued):

3. *Install two idler shaft restraint blocks (PN AK00-003) on both sides of the inside of the bottom plate in the locations shown in the following illustration. Secure each block to the bottom plate using 3/8" NC x 1-1/4" hex bolts and lock washers.*

ILLUSTRATION 3.H.2: IDLER SHAFT RESTRAINT BLOCK INSTALLATION

4. *Install rotary gear, making sure the backing pin slots are on the side facing up. The bottom side of the rotary gear rides on top of the manganese bronze cam follower washers installed in the step 2.*
5. *Press pinion bearing (PN 1234-08-01B) into bottom pinion bearing cap (PN AK01-151), and install bearing cap into bottom plate of tong using four 1/2" NC x 1-1/4" hex bolts and 1/2" lock washers.*
6. *Press lower clutch bearing (PN 02-0076) into clutch bearing cap (PN AK01-201), and install bearing cap into bottom plate of tong using four 3/8" NC x 1-1/4" hex bolts and 3/8" lock washers.*
7. *Lightly grease each rotary idler shaft (PN AK01-101). Slide a lower thrust pad (PN AK01-103) over the top of each shaft and ensure it is snug against the flange on the idler shaft.*
8. *Slide two inner bearing rings (PN 02-0358) over the top of each rotary idler shaft and ensure they are tight to the lower thrust pads. Press two needle bearings (PN 02-0361) over each rotary idler shaft and press tight to lower thrust pads.*
9. *Press a rotary idler gear (PN AK01-102) over each set of two bearings on the rotary idler shafts.*
10. *Slide a top thrust pad (PN AK01-104) over the top of each rotary idler shaft and ensure it is snug against the idler gear.*
11. *Place each rotary idler assembly through the bottom plate, ensuring the flats on the idler shaft flanges are square to the idler restraint blocks installed in Step 3.*
12. *Slide the high pinion gear (PN 997-A4-87B) over the end of the pinion gear shaft (PN 997-A7-86B). Ensure the pinion gear is oriented correctly when installing the high pinion gear - see Pp. 5.8 - 5.9 for an exploded view. Place the end of the pinion shaft with the high pinion gear into the lower pinion bearing installed in Step 5.*
13. *Install one retainer clip (PN 02-0009) into each pinion idler gear (PN AK01-122). Lightly grease the inside of the gears, and press a rotary idler bearing (PN 02-0075) into each gear, tight to the previously installed retainer. Secure each bearing with another retainer clip (PN 02-0009).*
14. *Insert each pinion idler half-shaft through the pinion idler gear assemblies. Place a bearing seal (PN 02-0010) over the end of each pinion idler shaft, and secure shafts and seals to the gear assemblies using a small retainer ring (PN 02-0008).*
15. *Place the ends of each pinion idler through the bottom plate, ensuring the pinion idler gears mesh smoothly with the rotary idler gears and the pinion gear shaft.*
16. *Place the tong body stiffener plate (PN AK00-001) onto the bottom of the tong, and secure the stiffener plate in place with the 1/2" NC x 2-1/2" hex bolts,1/2" lock washers, and 1-1/2" UNF nylock nuts used to secure the pinion idler half-shafts to the bottom plate. Secure the rear of the stiffener plate with a 1/2" NC x 1-1/4" hex bolt and 1/2" lock washer, next to the clutch bearing cap (see Illustration 3.H.3).*

Assembly Procedures (continued):

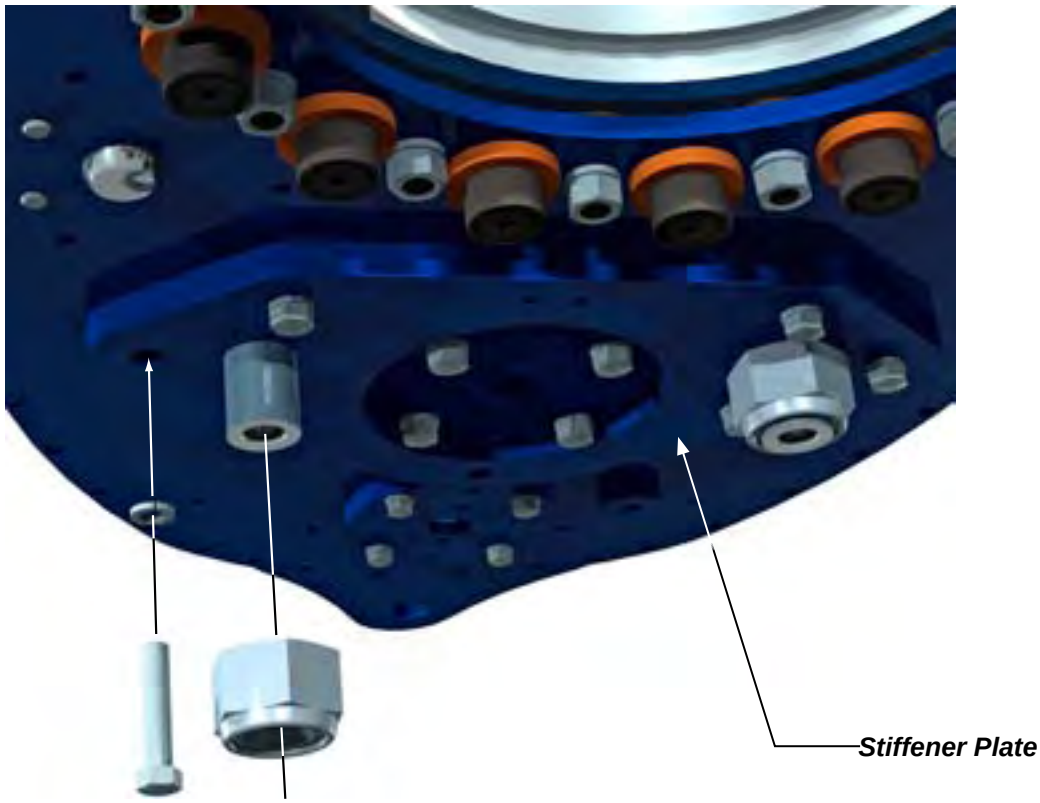

ILLUSTRATION 3.H.3: BOTTOM STIFFENER PLATE INSTALLATION

17. *Lightly grease clutch o-ring (PN 08-1240) and insert into the o-ring groove in the clutch bearing cap.*

ILLUSTRATION 3.H.4: CLUTCH O-RING INSTALLATION

Assembly Procedures (continued):

18. *Lightly grease all four needle bearings (PN 02-1404), and slide two bearings over each end of the clutch shaft and press tight to the center gear in the clutch shaft.*
19. *Slide the high clutch gear (PN 997-HT-51B) over the bottom end of the clutch shaft (the bottom end of the clutch shaft can be identified by the threaded 1/8" NPT port for a grease fitting) and press on to the two needle bearings on that side of the center gear on the clutch shaft. Ensure the gear is properly oriented on the shaft - the smaller diameter portion of the gear must be oriented toward the center clutch shaft gear.*
20. *Slide the lower clutch spacer (PN 997-99) over the bottom end of the clutch shaft - the side of the spacer with the small shoulder should be oriented toward the lower clutch bearing and the flat side against the high clutch gear.*
21. *Insert the bottom end of the clutch shaft into the clutch bearing cap, ensuring that the o-ring does not become dislodged - the o-ring should slide over the outside circumference of the clutch shaft. Mesh the high clutch gear with the high pinion gear.*
22. *Slide the shifting collar (PN 997-HT-62) over the top of the clutch shaft and mesh with the center clutch shaft gear.*
23. *Slide the low clutch gear (PN 997-HT-52) over the top of the clutch shaft and press onto the remaining two needle bearings - press tight to clutch shaft shaft center gear.*
24. *Slide clutch gear spacer (PN AK01-204) over the top of the clutch shaft and press tight to the low clutch gear.*
25. *Slide the low pinion gear (PN 997-A5-88) on to the pinion gear shaft, ensuring that the smaller diameter shoulder on the low pinion gear is facing up.*
26. *Insert two positioning dowel pins (PN 09-0092) into the two un threaded holes in the side body weldment on either side of the door opening.*
27. *Install the remaining cam follower assemblies into their proper locations in the top body plate (see Illustration 3.H.5).*

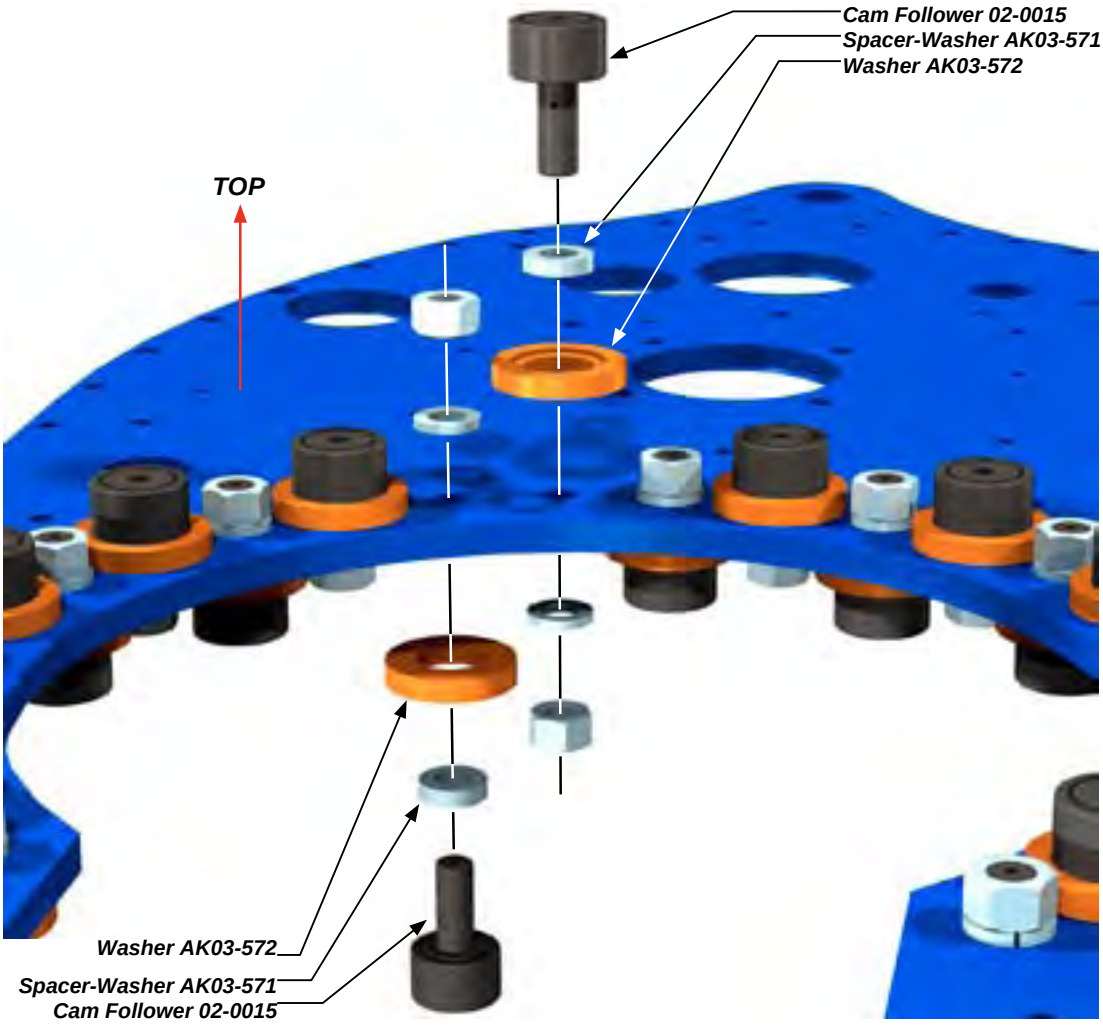

ILLUSTRATION 3.H.5: CAM FOLLOWER INSTALLATION (TOP PLATE)

Assembly Procedures (continued):

28. *Install top plate onto side body assembly. Secure plate with 3/8" NC x 1-1/2" hex bolts and 3/8" lock washers, and 3/8" NC x 1-1/4" hex socket head cap screws. Do not install fasteners in the rigid sling bracket locations as shown in the following illustration:*

ILLUSTRATION 3.H.6: RIGID SLING BRACKET INSTALLATION LOCATIONS

Do not install fasteners in the front leg mount locations on the top and bottom plates as shown in the following illustration:

ILLUSTRATION 3.H.7: FRONT LEG MOUNT LOCATIONS

Do not install fasteners in the eight rear-most locations on the top plate, and the six rear-most locations on the bottom plate as shown in the following illustration.

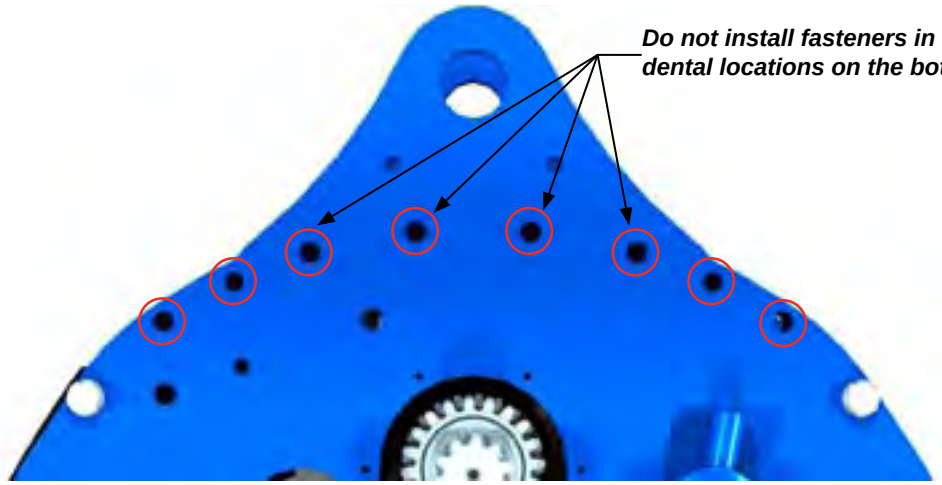

ILLUSTRATION 3.H.8: REAR LEG MOUNT LOCATIONS

Assembly Procedures (continued):

29. *Press top clutch bearing (PN 02-0077) into the top clutch bearing retainer (PN AK01-203), and install top clutch bearing/ bearing retainer on to the top plate using six 10-24 x 3/4" hex socket head cap screws.*
30. *Slide the bearing spacer (PN AK01-205) over the end of the clutch shaft.*
31. *Install clutch drive gear (PN 997-HT-61) on to the end of the clutch shaft, ensuring the "cut out" on the drive gear faces up. Secure with an external snap ring (PN 1234-00-04).*
32. *Press the remaining pinion bearing (PN 1234-08-01B) into the top pinion bearing cap (PN 997-D15-89). Install the pinion bearing/bearing cap on to the top plate of the tong over the pinion shaft, ensuring that the pinion bearing spacer (PN 1400-89A) is placed between the bearing cap and the top plate. Secure with four 1/2" NC x 1-1/4" hex bolts and 1/2" lock washers.*
33. *Position the shifting fork (PN 997-HT-72) in its proper position, engaged with the shifting collar. Lightly grease the shifting shaft (PN 1400-71) and insert through the top shifter bushing, which is typically welded to the top plate. Continue to insert the shaft through the shifting fork, and secure the shaft to the fork with a 5/8" UNF hex nut, and a 5/8" UNF hex jam nut.*
34. *Insert the shifter detent ball (PN 02-0018) into the detent tube on the top shifter bushing. Insert the shifter detent spring (PN 997-0-64) into the detent tube. Thread a 7/16" UNF jam nut on to the 7/16" UNF x 1-1/4" hex bolt, and then thread the bolt into the end of the detent tube. Lock the bolt to the detent tube with the hex nut. See Pg. 3.7 for information about adjusting the shifter detent tension.*
35. *Place two 5/16" motor mount positioning dowel pins (PN 09-0170) in to their locations in the un-threaded holes adjacent to the the clutch drive gear.*
36. *Install the motor mount (PN 1064-C8-150) and secure with four 1/2" NC x 2" hex socket head cap screws.*
37. *Install 3/8" x 3/8" x 1-1/2" square key into the key slot on hydraulic motor shaft. Install motor gear (PN 997-A10-149) on to the hydraulic motor shaft over the key, and secure with two 3/8" NC x 3/8" flat point hex socket set screws.*
38. *Install motor on to motor mount. Secure the RH side of the motor (as seen from the back of the tong) with two 1/2" NC x 1-1/2" hex socket head cap screws and 1/2" lock washers. The torque gauge holder weldment (PN 1500-09-04A) is secured by the two LH motor screws - position the torque gauge holder weldment in place, and secure it and the LH side of the motor with two 1/2" NC x 1-1/4" hex socket head cap screws and 1/2" lock washers.*
39. *Attach the two #20 (1-1/4") x JIC 1" flange elbows (PN 02-9216) to the motor ports using two #20 split flange kits (PN 02-9217).*
40. *Attach the shifter lug weldment (PN 101-0016) to the top plate of the tong next to the top shifter bushing weldment using four 3/8" NC x 1" hex bolts and 3/8" lock washers.*
41. *Connect the shifter handle weldment's (PN AK00-092) pivot point to the pivot point of the shifter lug weldment using a 5/16" x 1-1/2" clevis pin. Connect the end of the shifter handle weldment to the top of the shifter shaft using a 5/16" x 1" clevis pin. Secure the clevis pins with .093" X 1.125" hitch pins.*
42. *Install the two front cage plate spacers (PN AK20-031) in the bottom cage plate weldment (PN AK20-20W, and secure the bottoms of the two spacers with two 5/16" NC hex nylock nuts and 5/16" narrow flat washers. Lightly grease the support slot in the bottom cage plate, and hold the cage plate in place over the bottom cam followers.*
43. *Lightly grease the support slot in the top cage plate (PN AK20-010), and set the cage plate in place over the support cam followers. Insert the rear cage plate spacer (PN AK20-032) between the top and bottom cage plate, and secure the two cage plates together with two 3/8" NC x 6-1/2" hex bolts, 3/8" NC nylock nuts, and two each 3/8" narrow flat washers. Secure the top of the front cage plate spacers with two 5/16" NC hex nylock nuts and 5/16" narrow flat washers.*
44. *Insert the rear cage plate bolt (PN AK20-033) through the center of the rear cage plate spacer, and secure on the bottom with a 3/8" NC nylock nut and 3/8" narrow flat washer.*
45. *Install the remainder of the backing pin assembly (See Pp. 5.14 - 5.15 for more detail).*
46. *Install upper and lower lined brake band weldments (PN AK29-001). Secure the rear of the top brake band to the top plate with a brake band retainer (PN 101-1858) and two 3/8" NC x 1" hex bolts and 3/8" lock washers. Secure the rear of the lower brake band to the bottom stiffener plate with a brake band retainer (PN 101-2360) and two 3/8" NC x 1-1/4" hex bolts and 3/8" lock washers. Install front adjustment bolts and nuts - one 1/2" NC x 2" hex bolt and 1/2" NC nylock nut per adjustment point.*
47. *Press a sleeve bearing (PN 02-0238) into the door latch bar weldment (PN AK12-756) and the door latch trigger (PN AK12-755). Secure the door latch bar weldment to the front plate of the LH door weldment using a 1/2" x 5/8" shoulder bolt. Secure the door latch trigger to the INSIDE (directly behind the LH door handle) of the inverted U-tab on the bottom plate of the LH door weldment using a 1/2" x 5/8" shoulder bolt. Ensure the front of the latch trigger is in a position to lift the door latch bar when it is squeezed. Install the door latch spring (PN AK12-757) between the bottom plate of the door weldment and the rear of the latch bar, over the pin tabs that have been welded to each.*
48. *Install a sleeve bearing (PN 02-0495) into the top and bottom plates of both door weldments (four locations total).*
49. *Position the RH door assembly in its proper location - ensure there is a thrust bearing (PN AK12-001) between the top and bottom tong body plates and the top and bottom plates of the door weldment. Insert a door pin (PN AK12-708) from the top, and secure the door pin on the bottom with a 1" external snap ring. Repeat the process with the RH door assembly.*

Assembly Procedures (continued):

50. ***BACKUP-READY TONG ONLY:*** *Attach the RH front leg mount weldment (PN 101-2067) to the bottom of the tong near the RH door using three 3/8" NC x 1-1/2" hex bolts, two 3/8" NC hex bolts, and three 3/8" lock washers. Attach the LH front leg mount weldment (PN 101-2069) to the LH front of the tong, on the bottom.*
51. ***BACKUP-READY TONG ONLY:*** *Attach the RH leg support plate weldment (PN 101-2070) to the top plate over the RH leg mount weldment. Secure the plate with three 3/8" NC x 1-1/2" hex bolts, two 3/8" NC hex bolts, and three 3/8" lock washers. Repeat with the LH leg support plate weldment (PN 101-2072).*
52. *Install a door cylinder bracket (PN AK12-706) to the top of each door assembly using two 3/8" NC x 1-1/4" hex bolts and 3/8" lock washers per bracket.* ***STAND-ALONE TONG ONLY:*** *Install a rear door cylinder mount weldment (Right Hand: PN AK12-030RH, Left Hand: PN AK12-030) to the top plate directly adjacent to each brake band adjustment using two 3/8" NC x 2" hex bolts and 3/8" lock washers per weldment.*
53. *Install a door cylinder (PN 101-0069) onto each cylinder bracket and the rear mounting lugs. Secure the cylinders with two 3/8" NC x 1-1/2" hex bolts, 3/8" lock washers, and 3/8" narrow flat washers. Do not neglect to install a door bushing (PN 997-13B) through the mounting holes in each end of the door cylinders.*
54. *Install the RH rigid sling bracket (PN 101-1244) and the LH rigid sling bracket (PN 101-1245). Secure each bracket to the top plate with two 3/8" x 2" hex bolts and lock washers on the outside, and two 3/8" NC x 7" hex bolts and lock washers on the inside. Note that the 7" long bolts run down through the body spacers and thread into the bottom plate.*
55. *Secure the two remaining body spacers, located just next to the brake bands adjacent to the rotary idlers, using a 3/8" NC x 6" hex bolt, two 3/8" narrow flat washers, and a 3/8" NC nylock nut per spacer.*
56. *Attach the rigid sling weldment to the two rigid sling brackets using one rigid sling pin (PN AK00-056) per side. Secure each rigid sling pin with two 0.243" x 5.125" hitch pins.*
57. ***STAND-ALONE TONG ONLY:*** *Attach the two rear leg weldments (Right Hand PN: 101-1678, Left Hand PN: 101-1677) to the bottom plate of the tong using three 3/8" NC x 2-1/4" hex bolts and 3/8" lock washers per weldment.*
58. *Pre-mount the main hydraulic inlet line to the inlet section on the valve bank. Mount the main valve bank to the valve mount weldment (PN AK00-070B) using four 1/2" NC x 4-1/2" hex bolts, two 1/2" narrow flat washers per bolt, and four 1/2" NC nylock nuts. Secure the hydraulic line to the top of the valve mount weldment using a 3/8" NC threaded U-bolt (PN 101-2075) and two 3/8" NC nylock nuts.*
59. *Install the valve mount weldment on the top plate, directly over the top pinion bearing cap. Secure with four 3/8" NC x 1" hex bolts and 3/8" lock washers.*
60. *Attach the inlet coupling support weldment (PN 101-1138) to the top plate directly behind the RH rigid sling bracket. Secure with two 3/8" NC x 1" hex bolts and 3/8" lock washers. Attach the adjustment plate (PN 101-3947) to the support weldment using four 3/8" NC x 1" hex bolts, two 3/8" narrow flat washers per bolt, and four 3/8" NC nylock nuts.*
61. *Attach the valve mount handle weldment (PN AK00-076) to the top LH side of the valve mount weldment (as seen from the rear of the tong) using two 5/16" NC x 1" hex bolts, two 5/16" narrow flat washers per bolt, and two 5/16" NC nylock nuts.*
62. *Install the safety door components (See Pp. 5.26 - 5.27 for more detail) using the following procedure:*
    i. *Coat the threads of the Deltrol safety door valve valve (PN 08-0337M) with Loctite®. Thread the Deltrol valve into the valve-end mounting tube (PN 101-4236).*

ILLUSTRATION 3.H.9: SAFETY DOOR COMPONENT ASSEMBLY 01

Assembly Procedures (continued):

62. *Install the safety door components (continued):*

ii. *Thread a 7/16" UNF hex jam nut on to one end of the safety door push-pull cable (PN 02-E0026). Thread the nut completely on to the end of the cable.*

iii. *Slide two mounting brackets (PN 02-E0025) over the mounting tube/Deltrol valve assembly. Thread the mounting tube/Deltrol valve assembly on to one end of the safety door push-pull cable. Continue threading the mounting tube until the plunger on the Deltrol valve contacts the end of the push-pull cable.*

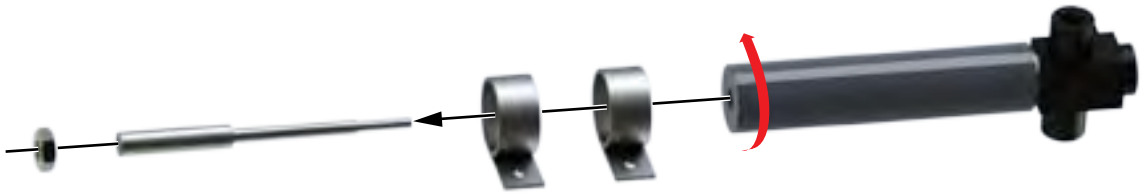

ILLUSTRATION 3.H.10: SAFETY DOOR COMPONENT ASSEMBLY 02

iv. *Attach the mounting tube to the valve mount weldment using two 1/4" UNC x 1" hex bolts, 1/4" narrow flat washers, and 1/4" UNC hex nylock nuts.*

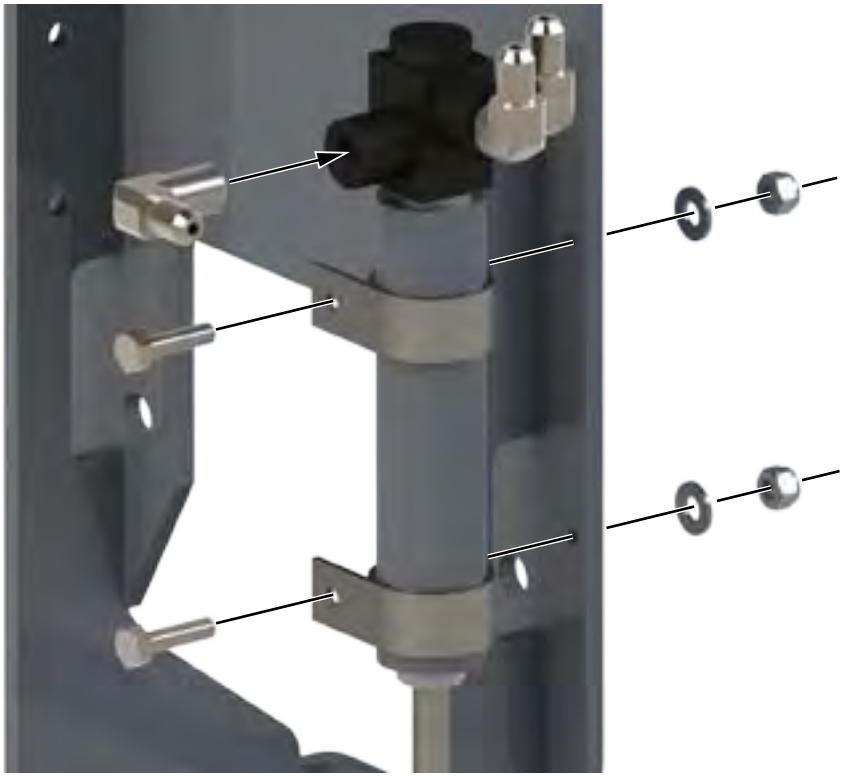

ILLUSTRATION 3.H.11: SAFETY DOOR COMPONENT ASSEMBLY 03

v. *Secure the valve mounting block (PN AE13-301) to the right-hand door weldment using four 3/8" x 3/8" hex socket head UNC shoulder bolts.*

vi. *Secure the safety door hook block (AE13-302) to the left-hand door weldment using two 3/8" UNC x 1" hex socket head cap screws.*

Assembly Procedures (continued):

62. *Install the safety door components (continued):*
    - vii. *Slide the protective spring (PN 02-E0099) completely over the safety door push-pull cable.*
    - viii. *Thread another 7/16" UNF hex jam nut on to the remaining end of the safety door push-pull cable. Thread the nut completely on to the end of the cable.*
    - ix. *Thread the door-end mounting tube (PN 101-5483) on to the remaining end of the push-pull cable. Thread the mounting tube until the threaded end of the push-pull cable protrudes through the tube.*
    - x. *Thread the safety door plunger (PN 101-4360) on to the exposed end of the push-pull cable.*

ILLUSTRATION 3.H.12: SAFETY DOOR COMPONENT ASSEMBLY 04

- xi. *Un-thread the door-end mounting tube, causing the plunger to retract inside the mounting tube until only approximately 1/4" remains protruding. Lock the mounting tube in place using the 7/16" UNF hex jam nut.*
- xii. *Insert the safety door cable mounting tube (PN 101-5483) in to the mounting block on the RH door assembly, and secure with a 15/16" valve lock nut (PN 09-0278).*

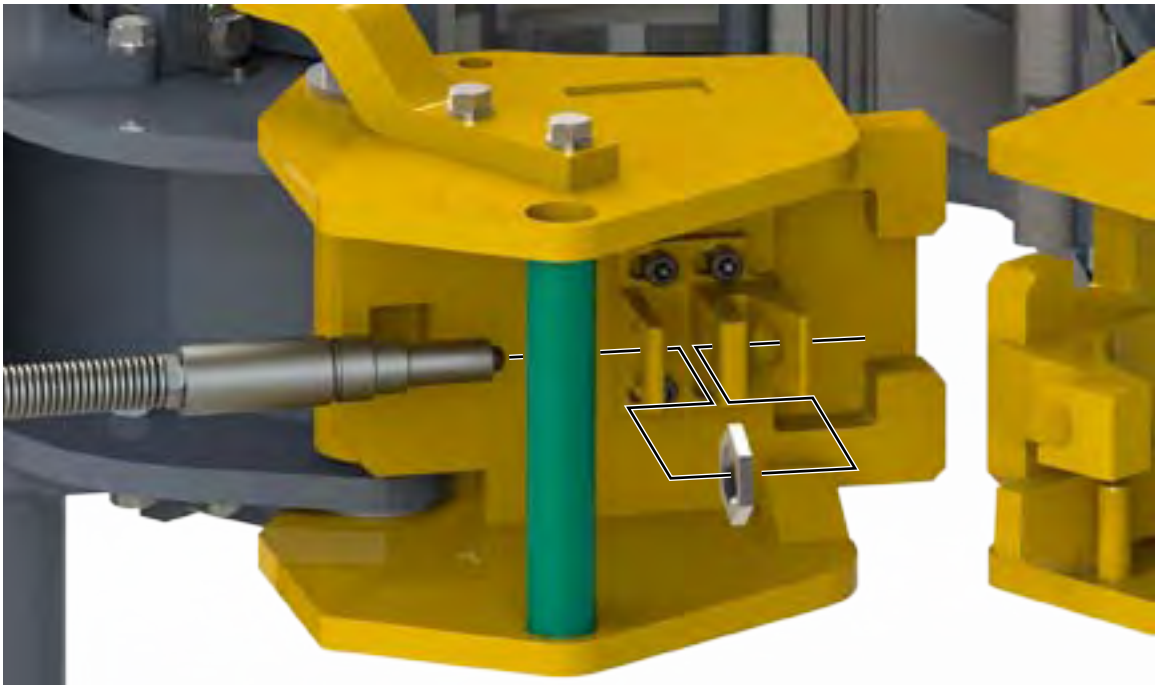

ILLUSTRATION 3.H.13: SAFETY DOOR COMPONENT ASSEMBLY 05

Assembly Procedures (continued):

63. *Install grease fittings as follows:*
    - i. *Install a 1/4" UNF straight thread grease fitting (PN 02-0097) in the end of each rotary idler shaft, located on the top side of the tong.*
    - ii. *Install a 1/8" NPT grease fitting (PN 02-0005) in the end of each pinion idler half-shaft, located on the the bottom side of the tong.*
    - iii. *Install two 1/8" NPT 90 degree grease fittings (PN 02-0093) in each pinion bearing cap*
    - iv. *Install two 1/8" NPT 90 degree grease fittings (PN 02-0093) in the clutch bearing cap on either side of the center hole, and one 1/8" NPT grease fitting (PN 02-0005) in the end of the clutch shaft, accessed through the center hole in the clutch bearing cap.*
    - v. *Install a 1/8" NPT 90 degree grease fitting (PN 02-0093) in the threaded port on top of the motor mount.*
    - vi. *Install a 1/8" NPT grease fitting (PN 02-0005) in the end of each of the backup clamp cylinder.*

I. DAILY INSPECTION & MAINTENANCE CHECKLIST (POWER TONG)

Farr recommends that the following inspection and maintenance procedures be performed before each use, and at least once per day when the tong is in steady use, in the order in which they are listed.

1. ☐ *Rotate cage plate/rotary gear until the opening in the rotary gear faces towards the rear of the tong.*

DO NOT PERFORM ANY FURTHER ACTIONS OR MAINTENANCE WHILE THE TONG IS CONNECTED TO ANY HYDRAULIC POWER SUPPLY. FARR RECOMMENDS THAT ALL HYDRAULIC LINES ARE FULLY DISCONNECTED, AND RESIDUAL HYDRAULIC PRESSURE IS BLED OFF. ENSURE ADEQUATE CONTAINMENT IS IN PLACE TO PREVENT ENVIRONMENTAL CONTAMINATION FROM RESIDUAL HYDRAULIC FLUID.

DEPRESSURIZE HYDRAULIC SYSTEM IN PREPARATION FOR MAINTENANCE:

2. ☐
   1) *Rotate the tong to the "open throat" position. Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder*
   2) *De-energize the power unit.*
   3) *Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.*
   4) *Remove the hydraulic SUPPLY line from the equipment.*
   5) *Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.*
   7) *Disconnect the hydraulic RETURN line from the equipment.*
   8) *Disconnect remaining hoses such as case drains, or lines connected to the turns counter.*

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE INJURIES

3. ☐ *Perform an initial wash of the tong in order to remove the majority of dirt and grease build-up. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid and dirty grease.*

4. ☐ *Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.*

5. ☐ *Use a flashlight to perform a visual inspection of the gear train through the access panel and the opening of the rotary gear. If gear damage or chips of metal are seen, the tong should be removed from service and overhauled to avoid further damage. Replace access panel when inspection is complete.*

6. ☐ *Perform a visual inspection of all fasteners and protruding body pieces (example: hydraulic valve mounts, inlet & outlet line supports, tong legs, shifter handle pivot lugs). Tighten or replace loose or missing fasteners. Farr recommends that damaged or missing body parts be repaired or replaced as soon as possible.*

7. ☐ *Inspect the jaws and dies. Inspect the jaw roller pins for signs of damage - replace pins if necessary. If the pins are welded in place, replace the entire jaw assembly. Ensure dies are secure in the jaw - replace worn dies if necessary. Ensure that the jaw rollers rotate freely. Check to ensure the size of the loaded jaws match the size of casing or pipe you are running.*

8. ☐ *Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service.*

9. ☐ *Inspect tong for signs of premature wear, or moving parts that are rubbing (bare metal where there used to be paint is a good indication of wear.*

10. ☐ *Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.*

11. ☐ *Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.*

12. ☐ *Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object.*

13. ☐ *Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object.*

14. ☐ *Perform a complete greasing of the tong - refer to Maintenance section of the technical manual*

15. ☐ *Ensure main supply and return connections to the tong are fully made up. Re-connect the remainder of the hydraulic lines, and, if applicable, the electrical line to the turns counter.*

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

If using a stand-alone power unit, start it now - refer to the power unit technical manual for startup procedures. Listen to power unit for a moment to see if there are any unusual mechanical sounds (rubbing, grinding, excessive pump noise). If using a diesel unit, allow sufficient time for the engine to reach operating temperature before increasing engine RPM. Once engine is warm, gradually increase engine RPM until operating speed is reached.

16. ☐ *Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.*

17. ☐ *Perform a visual inspection of pressurized hydraulic lines. Document and correct any hydraulic fluid leaks.*

18. ☐ *Perform a full functional test of the tong. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.*

19. ☐ *Perform a visual inspection of the load cell. If using a tension load cell, replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.*

20. ☐ *If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.*

21. ☐ *If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.*

22. ☐ *Test safety door feature (if equipped). Open the tong door(s), and attempt to rotate the cage plate at low speed (low gear) in both directions (makeup and breakout). If cage plate begins rotating, the safety door mechanism is not functional, and the tong must be removed from service until the safety door mechanism can be repaired. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.*

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

23. ☐ *While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved.*

J. MONTHLY MAINTENANCE CHECKLIST - POWER TONG

The following maintenance checklist is intended as a guideline rather than a definitive maintenance schedule. Your equipment may require more, or less, maintenance depending upon the frequency of use, the percentage of maximum torque that your equipment is routinely subjected to, and the field conditions under which your equipment operates. Farr recommends that the following inspection and maintenance procedures be performed monthly, or in conjunction with your maintenance foreman's experience and best estimate of when your equipment is due for this maintenance.

1. ☐ *Rotate cage plate/rotary gear until the opening in the rotary gear faces towards the rear of the tong.*

DO NOT PERFORM ANY FURTHER ACTIONS OR MAINTENANCE WHILE THE TONG IS CONNECTED TO ANY HYDRAULIC POWER SUPPLY. FARR RECOMMENDS THAT ALL HYDRAULIC LINES ARE FULLY DISCONNECTED, AND RESIDUAL HYDRAULIC PRESSURE IS BLED OFF. ENSURE ADEQUATE CONTAINMENT IS IN PLACE TO PREVENT ENVIRONMENTAL CONTAMINATION FROM RESIDUAL HYDRAULIC FLUID.

DEPRESSURIZE HYDRAULIC SYSTEM IN PREPARATION FOR MAINTENANCE:

2. ☐
   1) *Rotate the tong to the "open throat" position. Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder*
   2) *De-energize the power unit.*
   3) *Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.*
   4) *Remove the hydraulic SUPPLY line from the equipment.*
   5) *Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.*
   7) *Disconnect the hydraulic RETURN line from the equipment.*
   8) *Disconnect remaining hoses such as case drains, or lines connected to the turns counter.*

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE INJURIES

3. ☐ *Clean the exterior of the tool thoroughly, using either water (if using a pressure washer ensure a low-pressure wash wand is used), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents.*

4. ☐ *Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.*

5. ☐ *Clean the interior of the tong thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents. Make a note if any metal shavings or metal pieces are flushed out of the gear train cavity - if shavings or metal pieces are seen the tong must be overhauled before it is returned to service.*

6. ☐ *Inspect all fasteners and fastener safety wires (if equipped). Replace any missing fasteners - use Grade 8 bolts only unless otherwise specified. Re-torque all external fasteners to SAE specifications.*

7. ☐ *Repair or replace any damaged or missing external body parts, such as torque gauge mounts, hydraulic supports, safety door protectors, etc.*

8. ☐ *Perform a visual inspection of all fasteners and protruding body pieces (example: hydraulic valve mounts, inlet & outlet line supports, tong legs, shifter handle pivot lugs). Tighten or replace loose or missing fasteners. Farr recommends that damaged or missing body parts be repaired or replaced as soon as possible.*

9. ☐ *Inspect tong for signs of premature wear, or moving parts that are rubbing (bare metal where there used to be paint is a good indication of wear.*

10. ☐ *Inspect all paint - locations in which the paint has been damaged must be repaired prior to the tong being returned to service. Prepare areas to be painted to ensure they are free of grease, dirt, or solvent. Touch up using a solvent-based acrylic paint - "McCoy Grey" is paint color number RAL7015 (contact Farr sales for paint number for custom paint applications). Allow sufficient time for paint to dry before proceeding.*

11. ☐ *Inspect all external welds. Any weld that is cracked or separating must be repaired and repainted before returning the tong to service.*

12. ☐ *Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service. Refer to Section 2A of the technical manual (Sling/Load Bearing Device Safety) for information on recommended testing and recertification. Please note that turnbuckles with part number 101-3086 (short turnbuckles) use a high-strength pin which must be supplied by Farr.*

"SHORT" TURNBUCKLES HAVING PART NUMBER 101-3086 EMPLOY HIGH-STRENGTH PINS WHICH MUST BE SUPPLIED BY FARR.

13. ☐ *Rotate the gear train by hand, and use a flashlight to perform a visual inspection of the gear train through the access panel and the opening of the rotary gear while the gear train is being rotated. If gear damage or chips of metal are seen, the tong should be removed from service and overhauled to avoid further damage. Replace access panel when inspection is complete.*

14. ☐ *Inspect all jaws and dies in use for the maintenance interval. Inspect the jaw roller pins for signs of damage - replace pins if necessary. If the pins are welded in place, remove and quarantine the jaw until the weld is repaired. Ensure dies are secure in the jaw - replace worn dies if necessary. Ensure that the jaw rollers rotate freely.*

15. ☐ *Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.*

16. ☐ *Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.*

17. ☐ *Inspect door springs. Ensure the springs retain sufficient strength to be able to assist the opening of the door, and to keep the door open. The springs should also help to "snap" the door shut.*

18. ☐ *Inspect backup springs (if applicable). The rear extension springs should be equally extended, and the front leg springs should be equally compressed. Ensure that neither of the rear backup springs have been over-extended and lack sufficient tension to adequately support the backup. Ensure that neither of the front leg springs have been over-compressed, and still retain enough spring strength to support the front of the backup.*

19. ☐ *Extend all hydraulic cylinders, and inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced prior to storage.*

20. ☐ *Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object. If your tong is equipped with rigid hydraulic lines, replace any line that is dented or appears to be stressed or cracked.*

21. ☐ *Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear. Perform a full lubrication - refer to Maintenance section of manual to determine lubrication points.*

22. ☐ *Ensure main supply and return connections to the tong are fully made up. Re-connect the remainder of the hydraulic lines, and, if applicable, the electrical line to the turns counter.*

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

If using a stand-alone power unit, start it now - refer to the power unit technical manual for startup procedures. Listen to power unit for a moment to see if there are any unusual mechanical sounds (rubbing, grinding, excessive pump noise). If using a diesel unit, allow sufficient time for the engine to reach operating temperature before increasing engine RPM. Once engine is warm, gradually increase engine RPM until operating speed is reached.

23. ☐ *Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.*

24. ☐ *Perform a visual inspection of pressurized hydraulic lines. If any hydraulic fittings or hoses are leaking they must be repaired or replaced before proceeding.*

25. ☐ *Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train. De-energize the power unit, and perform another generous lubrication of the gear train, including the gear housing.*

26. ☐ *Energize power unit. Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train.*

27. ☐ *De-energize the power unit, and perform a third generous lubrication of the gear train, including the gear housing.*

28. ☐ *Re-energize power unit and extend all hydraulic cylinders. Inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced.*

29. ☐ *Rotate tong in low gear for 5 minutes while monitoring pressurized seals and hydraulic lines. If a seal, line, or fitting begins to leak while tong is rotating, it must be replaced before the equipment is returned to service.*

30. ☐ *Rotate tong in high gear for 5 minutes while monitoring temperature of top and bottom bearing caps. If the bearing caps are hot to the touch (higher than approximately 50°C) replace the applicable bearings. Likewise if the tong is making unusual noises check for damaged bearings (see Maintenance Manual for all bearing locations).*

31. ☐ *Install load cell. If using a tension load cell, perform a visual inspection and replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.*

32. ☐ *If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.*

33. ☐ *If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.*

34. ☐ *Inspect load cell for damage or signs of stress. Check oil level in load cell and fill if necessary (refer to technical manual Section 7 or Section 8).*

35. ☐ *While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.*

36. ☐ *Perform a full functional test of the tong including, if applicable, backup components, lift cylinder, and float frame components. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.*

37. ☐ *Test safety door feature (if equipped). Begin rotating the tong at low speed, and open the tong door(s). If rotation does not immediately stop, this is an indication that the safety door mechanism is not operating correctly and the tong must be removed from service until the mechanism is repaired. Repeat the test while operating the tong in the opposite direction. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.*

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

38. ☐ *Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external unpainted surfaces (and chain slings) EXCEPT cylinder rods, jaw rollers, and rotary gear camming surfaces. Refer to manufacturer data sheets for proper application and safety information.*

Once all of the above maintenance checklist items have been satisfactorily completed the tool may be returned to service.

K. DAILY INSPECTION & MAINTENANCE CHECKLIST (POWER UNIT)

Farr recommends that the following inspections and maintenance procedures be performed before each use, and at least once per day when the equipment is in steady use, in the sequence in which they are listed. Rigorous inspection and maintenance, especially lubrication, is essential in order to ensure that your equipment always meets specifications, and to prevent catastrophic failures that can severely damage your equipment and cause worker injury.

If using a stand-alone power unit, perform the following inspection and maintenance procedures before each use, and at least once per day when the power unit is in steady use:

Do not perform any maintenance while the power unit is energized (electric) or if the engine is running (diesel). Ensure the electrical supply is locked out, or, if using a diesel power supply, ensure that the engine is locked out or the starting mechanism otherwise disabled.

DIESEL ONLY

1. ☐ *Check engine oil levels - add if necessary*
2. ☐ *Check diesel fuel tank - fill if necessary.*
3. ☐ *Visually inspect all fan belts.*
4. ☐ *Activate mechanical shut-off device - ensure that shut-off switch on engine is engaging when manual shut-off switch is actuated.*

ELECTRIC ONLY

1. ☐ *Visually inspect all electrical lines and visible connections. If your unit is NOT explosion proof, open the electrical enclosure and VISUALLY inspect contacts and connections for signs of corrosion or arcing. Do not open explosion-proof enclosures.*

NEVER PLACE HANDS INSIDE AN ELECTRICAL ENCLOSURE UNLESS YOU HAVE CONFIRMED THAT THE POWER HAS BEEN DISCONNECTED AND LOCKED OUT

2. ☐ *Visually inspect main electrical line between main power source and power unit.*

ALL UNITS

5. ☐ *Perform a visual inspection of all parts. Check to ensure there are no loose or missing fasteners.*
6. ☐ *Check hydraulic fluid level - ensure cold level is approximately half-way up the sight glass on the hydraulic fluid reservoir.*
7. ☐ *Perform a visual inspection to ensure there are no hydraulic fluid leaks - correct if necessary.*
8. ☐ *Check that the main supply and return lines on the hydraulic fluid reservoir are both fully open.*
9. ☐ *Apply grease to any grease fittings that your power unit may have. Apply grease to each fitting until grease is visibly displaced from bearing, or as recommended by your power unit manual.*
10. ☐ *Ensure supply and return connections at the power unit and at the equipment in use are fully made up.*

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

11. ☐ *Check hydraulic fluid filter back pressure (must be done while fluid is circulating). If needle on indicator gauge is in the red zone, the filter should be changed the next time the unit is shut down*

L. TUBULAR CONNECTION EQUIPMENT DE-COMMISSIONING PROCEDURE

Perform the following decommissioning procedures when removing tubular connection equipment from service, with the intent of short to long-term storage. These procedures are essential for ensuring proper protection of the equipment from environmental attack, and to aid in the quick turnaround when returning the equipment to service.

Store all o-rings, seals, packings, gaskets, etc. in strong moisture proof, airtight containers. Ensure that these items are not crushed, nicked, or otherwise damaged.

Do not perform any further actions or maintenance while the tong is connected to any hydraulic power supply. Farr recommends that all hydraulic lines are fully disconnected, and residual hydraulic pressure is bled off. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid.

DEPRESSURIZATION PROCEDURE IN PREPARATION FOR STORAGE:

1) *Rotate the tong so that the opening in the rotary gear faces the gear train (towards the rear of the tong). Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder (if equipped). If mounted in a frame, retract the float cylinders (if equipped).*
2) *De-energize the power unit.*
3) *Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.*
4) *Remove the hydraulic SUPPLY line from the equipment.*
5) *Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.*
7) *Disconnect the hydraulic RETURN line from the equipment.*
8) *Disconnect remaining hoses such as case drains, or lines connected to the turns counter.*

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE-INDUCED INJURIES

1. ☐ *Perform an initial wash of the tool in order to remove the majority of dirt and grease build-up. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid and dirty grease.*
2. ☐ *Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.*
3. ☐ *Clean the interior of the tong thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents. Make a note if any metal shavings or metal pieces are flushed out of the gear train cavity - if shavings or metal pieces are seen the tong must be overhauled before it is returned to service.*
4. ☐ *Clean the exterior of the tool thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents.*
5. ☐ *Inspect all fasteners and fastener safety wires. Replace any missing fasteners - use Grade 8 bolts only. Re-torque all external fasteners to SAE specifications.*
6. ☐ *Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.*
7. ☐ *Repair or replace any damaged or missing external body parts, such as torque gauge mounts, hydraulic supports, safety door protectors, etc.*
8. ☐ *Inspect all paint - locations in which the paint has been damaged must be repaired prior to storage. Prepare areas to be painted to ensure they are free of grease, dirt, or solvent. Touch up using a solvent-based acrylic paint - "McCoy Grey" is paint number RAL7015. Allow sufficient time for paint to dry before proceeding.*
9. ☐ *Perform a liberal lubrication of the equipment - refer to Maintenance section of manual to determine lubrication points. Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear.*
10. ☐ *Connect the equipment to a hydraulic power unit. Ensure all lines are fully made up to prevent equipment damage from excessive back pressure. Do not neglect to connect the motor drain.*
11. ☐ *Energize power unit.*
12. ☐ *Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train. De-energize the power unit, and perform another generous lubrication of the gear train, including the gear housing.*

13. ☐ *Energize power unit. Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train.*

14. ☐ *De-energize the power unit, and perform a third generous lubrication of the gear train, including the gear housing.*

15. ☐ *Energize power unit, and rotate the tong for a final time, one minute in one direction, stop, and reverse the direction of rotation for another minute, this time ending with the rotary gear in the "open throat" position.*

16. ☐ *Extend all hydraulic cylinders, and inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced prior to storage.*

17. ☐ *If you are using a frame-mounted tool, the tong must be lowered onto the backup in order to remove the risk of sudden and catastrophic movement when pressure is removed from the float cylinders. Cover the top of the backup with protective cloth to protect the paint on the backup. Place two wooden beams across the top of the tong, ensuring that the beams have a minimum size of 4" x 4" x the width of the tong. Cover the tops of the wooden beams with more protective cloth to prevent paint damage to the tong. When lowering the tong onto the beams, ensure that the beams come into flat contact with the bottom of the tong, away from bearing caps, brake bands, or other protrusions on the bottom of the tong. Ensure that the tong hanger chains are loose, but not dangling into contact with the hangers or top plate of the tong.*

DEPRESSURIZATION PROCEDURE FOR STORAGE:

1) *Rotate the tong to the "open throat" position.*
2) *Exercise each hydraulic cylinder several times - open the tong and backup doors (if equipped), retract and extend the remote backing pin ramp (if equipped), retract and extend the float cylinders. Leave all cylinders except for the door cylinders in their fully retracted position. The general idea is to have as little of the chrome cylinder rods exposed as possible.*
3) *De-energize the power unit.*
4) *Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.*
5) *Remove the hydraulic SUPPLY line from the equipment.*
6) *Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.*
7) *Connect a low-pressure air supply line (10 PSI or less) to the hydraulic supply line, and force a small amount of the remaining hydraulic fluid from the valve assembly - this will allow for thermal expansion of the hydraulic fluid if the equipment is stored or transported in high ambient temperatures. Failure to do this may result in damaged or destroyed seals in the equipment.*
8) *Disconnect the hydraulic RETURN line from the equipment.*
9) *Disconnect remaining hoses such as case drains, or lines connected to the turns counter.*

18. ☐ *If any hydraulic fittings or hoses are leaking they must be repaired or replaced before proceeding.*

19. ☐ *Wipe all excess grease from outside of equipment. Replace the access door panel. Use a solvent-based cleaner on rags to wipe all external surfaces to remove residual grease or hydraulic fluid. Once the outside surfaces have been degreased, wipe all external surfaces with clean water to remove residual solvent.*

20. ☐ *Farr recommends that chain slings be removed and stored separately. Rigid slings and other rigid suspension devices may remain in place.*

21. ☐ *Apply grease or heavy oil to all exposed cylinder rods.*

22. ☐ *Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external surfaces EXCEPT cylinder rods (including chain slings). Refer to manufacturer data sheets for proper application and safety information.*

DO NOT ALLOW ANTI-CORROSIVE AGENTS TO CONTACT CYLINDER RODS. CYLINDER ROD DAMAGE WILL OCCUR.

23. ☐ *Allow the anti-corrosive coating ample time to dry - refer to manufacturer data sheets for drying times at room temperature.*

24. ☐ *Wrap entire assembly in 100 gauge (1 mil) corrosion-inhibiting wrap, at least 3 layers thick. Attempt to ensure that the tool is well-sealed within the wrapping, including the bottom.*

If possible, store in a sealed, climate controlled environment. If isolated storage is not available, Farr recommends storing your wrapped equipment in a secure, out-of-the-way location, using silica gel desiccant to reduce the humidity within the wrapping. As a guideline, use 125 g. of desiccant for each cubic metre of space, or 3.5 g. per cubic foot.

CALCULATION OF REQUIRED DESICCANT

1) *Calculate the trapped air volume by measuring the outside dimensions of the tool to be stored, and treat that as the volume to be stored. For example, the external dimensions of a KT20000 20" power tong are 80.25" x 50.5" x 28", which calculates to an approximate volume of 113500 in^3, or 66 ft^3 (1.87 m^3).*
2) *Multiply the calculated air volume, in cubic feet, by the recommended amount of desiccant per cubic foot. Carrying forth the example used in the previous step, the required desiccant charge would be 3.5 g. x 66 ft^3, equaling 231 g. Several manufacturers offer silica gel desiccant in packaged quantities of 125 grams per bag, so two packages of desiccant would be required. Please keep in mind that this is a guideline only - more or less desiccant may be required in extreme environmental conditions.*

For best corrosion resistance the equipment should be removed from storage and exercised on a regular basis, depending on the storage environment. Farr recommends that for equipment stored in a salt-water maritime or exposed dusty environment, repeat steps 9 through 24 monthly. For equipment stored in isolated storage in a non-maritime environment, repeat steps 9 through 24 quarterly. Replace desiccant packs at this time - depleted desiccant packs may be treated as regular dunnage.

N. TUBULAR CONNECTION EQUIPMENT RE-COMMISSIONING PROCEDURE

Perform the following recommissioning procedures when removing tubular connection equipment from short or long-term storage back into regular service. These procedures are essential for ensuring proper equipment preparation and operation. The following procedures also assume that the decommissioning and storage procedures recommended by Farr have been strictly observed.

1. ☐ *Remove all protective plastic wrapping. If there are desiccant packs with the assembly, they may be disposed of with the regular garbage.*
2. ☐ *Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.*
3. ☐ *Wipe excess grease or heavy oil from exposed cylinder rods.*
4. ☐ *If applicable, re-connect chain sling to lifting lugs. Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service. If your company requires yearly certification of lifting equipment, ensure that the most recent test date falls within the past year. Perform recertification if necessary.*
5. ☐ *Perform a liberal lubrication of the equipment - refer to Maintenance section of manual to determine lubrication points. Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear.*
6. ☐ *Connect the equipment to a hydraulic power unit. Ensure all lines are fully made up to prevent equipment damage from excessive back pressure. Do not neglect to connect the motor drain.*

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

7. ☐ *Energize power unit.*
8. ☐ *Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.*
9. ☐ *Perform a thorough inspection of pressurized hydraulic lines and fittings. Any leaking hydraulic fluid lines or fittings must be replaced before the equipment is returned to service.*
10. ☐ *Perform a thorough inspection of all seals. Any seal that is leaking or "weeping" must be replaced before the equipment is returned to service.*
11. ☐ *Rotate tong in low gear for 5 minutes while monitoring pressurized seals and hydraulic lines. If a seal, line, or fitting begins to leak while tong is rotating, it must be replaced before the equipment is returned to service. Finish this step with the rotary gear opening facing the gear train. De-energize the power unit.*
12. ☐ *Inspect all flexible hydraulic lines for signs of wear, blistering, or any other signs of potential failure - replace if signs of potential failure are identified.*
13. ☐ *Inspect the gear train housing. If the amount of grease is inadequate, liberally grease the gear train through the access panel, and through the opening in the rotary gear.*
14. ☐ *Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands. Ensure that all grease is wiped from brake band linings and the parts of the cage plates that come into contact with the brake band linings*
15. ☐ *Re-install access panel. Install a set of pre-inspected jaws that are the correct size for the pipe or casing being run.*
16. ☐ *Install load cell. If using a tension load cell, perform a visual inspection and replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.*
17. ☐ *If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.*
18. ☐ *If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.*
19. ☐ *Re-energize power unit.*

20. ☐ *Perform a full functional test of the equipment including, if applicable, backup components and float frame components. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.*

21. ☐ *If using a frame-mounted tong and backup system, raise the tong off the beams that it is resting upon. Remove the beams and protective cloths - inspect the paint on top of the backup and the bottom of the tong to ensure it has not been damaged by the beam.*

22. ☐ *Test safety door feature (if equipped). Open the tong door(s), and attempt to rotate the cage plate at low speed (low gear) in both directions (makeup and breakout). If cage plate begins rotating, the safety door mechanism is not functional, and the tong must be removed from service until the safety door mechanism can be repaired. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.*

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

23. ☐ *While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved.*

24. ☐ *When all of the previous steps are completed, you may return your re-commissioned equipment to service.*

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Adequate maintenance and proper fluid selection is essential for minimizing hydraulic-related failures. All troubleshooting must be performed by a technician trained in hydraulic systems, and familiar with the equipment design, assembly and operation.

The following troubleshooting instructions are intended to be guidelines only. Any faults not solved through the use of this guide should be referred to our engineering department for their evaluation and recommendations.

A. TONG WILL NOT DEVELOP SUFFICIENT TORQUE

1. *Malfunctioning relief valve on tong hydraulic circuit.*
   a. *POSSIBLE PROBLEM: Relief pressure set too low.*

      SOLUTION: Increase setting. To check, block the oil line beyond the relief valve and determine pressure with a gauge.

   b. *POSSIBLE PROBLEM: Relief valve is stuck.*

      SOLUTION: Check for contamination of oil that may inhibit the way the valve actuates. Remove valve and clean, ensuring that the valve spring operates smoothly.

   c. *POSSIBLE PROBLEM: Relief valve is leaking.*

      SOLUTION: Check valve seat for scouring. Check oil seals. Check for particles stuck under the valve system.

2. *POSSIBLE PROBLEM: Directional valve is leaking.*

   SOLUTION: Check directional valve. Neutral position should return fluid directly to the reservoir. Replace or repair valve to ensure correct operation.

3. *POSSIBLE PROBLEM: Power unit is not producing adequate pressure.*

   SOLUTION: Troubleshoot power unit (see user's manual for your particular unit).

4. *POSSIBLE PROBLEM: Poor hydraulic pressure at the tong despite adequate pressure at the power unit, or excessive back pressure in the return line.*

   SOLUTION: Restrictions exist in line between power unit and tong. Inspect integrity of self-sealing couplings to ensure they are allowing full fluid flow. Check to ensure no other restrictions exist (contaminated catch screens or filters, for example).

5. *POSSIBLE PROBLEM: Fluid viscosity is not appropriate (too high or too low).*

   SOLUTION: Ensure hydraulic fluid being used is the viscosity recommended by McCoy Drilling & Completions. Power unit pump may not prime if fluid is too heavy, and the hydraulic system will overheat if fluid is too light. Replace with proper viscosity fluid.

   SOLUTION: Hydraulic fluid viscosity is affected by environmental conditions. Ensure the fluid being used is suitable for high or low temperatures. Replace with proper viscosity fluid for the operating conditions if necessary.

6. *POSSIBLE PROBLEM: Worn or damaged tong motor causing slippage.*

   SOLUTION: Replace or repair worn or damaged motor.

7. *POSSIBLE PROBLEM: Damaged bearings or gears causing excessive drag.*

   SOLUTION: Replace or repair worn or damaged gears or bearings.

8. *POSSIBLE PROBLEM: Jaws slipping on pipe.*

   SOLUTION: Ensure jaw dies are not worn to the point that they cannot grip. Ensure the correct sized jaws are in use.

9. *POSSIBLE PROBLEM: Torque gauge is indicating incorrectly*

   SOLUTION: Incorrect gauge is being used. Ensure gauge is the proper range, and has been properly calibrated for the arm length of the equipment in use.

   SOLUTION: Gauge has been damaged. Check gauge operation and calibration on independent system.

TONG WILL NOT DEVELOP SUFFICIENT TORQUE Cont'd:

10. *POSSIBLE PROBLEM: Load cell is measuring incorrectly.*

    SOLUTION: Incorrect load cell is being used.

    SOLUTION: Air is trapped in torque measuring circuit (load cell, hydraulic line, or gauge. Refer to torque measurement trouble-shooting in Section 6 of this manual.

    SOLUTION: Load cell has been damaged. Replace load cell, or return to McCoy for repair and re-calibration.

FARR CANADA CORP. GUARANTEES CALIBRATION OF A LOAD CELL/TORQUE GAUGE ASSEMBLY FOR A PERIOD OF ONE YEAR. FARR CANADA CORP. SUGGESTS THAT THE LOAD CELL/TORQUE GAUGE ASSEMBLY BE RETURNED TO THE FACTORY FOR RE-CALIBRATION ON A YEARLY BASIS.

B. FAILURE OF JAWS TO GRIP PIPE

1. *POSSIBLE PROBLEM: Dies have become too dull to provide adequate grip.*
   SOLUTION: Replace dies.

2. *POSSIBLE PROBLEM: Incorrect jaws are being used.*
   SOLUTION: Double-check jaw size to ensure they are rated for the diameter of pipe or casing being run.

3. *POSSIBLE PROBLEM: Incorrect dies are being used*
   SOLUTION: Ensure dies loaded in the jaws are appropriate for the type of pipe or casing being run.

4. *POSSIBLE PROBLEM: Brake band(s) is (are) insufficiently adjusted, not allowing jaws to cam properly.*
   SOLUTION: Adjust brake bands to give proper resistance to cage plates.

5. *POSSIBLE PROBLEM: Jaw roller broken or worn.*
   SOLUTION: Remove jaw assembly and inspect. Replace rollers that are visibly "flat-spotted" or otherwise damaged.

C. TONG RUNNING TOO SLOWLY

1. *POSSIBLE PROBLEM: Obstruction in tong hydraulic circuit preventing adequate flow.*
   SOLUTION: Inspect self-sealing couplings to ensure they are properly engaged.
   SOLUTION: The main hydraulic lines (supply and discharge) to the tong are obstructed. Remove and clean if required.

2. *POSSIBLE PROBLEM: Power unit is not producing adequate flow or pressure.*
   SOLUTION: Troubleshoot power unit (see user's manual for your particular unit).

3. *POSSIBLE PROBLEM: Tong motor is excessively worn and is leaking hydraulic fluid past the vanes.*
   SOLUTION: Replace motor, or rebuild as per Section 7 of this manual.

4. *POSSIBLE PROBLEM: Bearings in gear train and rotary section are excessively worn.*
   SOLUTION: Overhaul tong. See Section 3 of this manual for tong overhaul procedures.

5. *POSSIBLE PROBLEM: Shifter has malfunctioned and the tong is not shifting to high gear.*
   SOLUTION: Inspect and repair shift mechanism as necessary.

6. *POSSIBLE PROBLEM: Two-speed hydraulic motor (if equipped) is not set to correct speed.*
   SOLUTION: Check motor, and set to the correct speed if required.

7. *POSSIBLE PROBLEM: Safety door system is not properly adjusted - hydraulic fluid leak past Deltrol valve.*
   SOLUTION: Check and adjust safety door system.

8. *POSSIBLE PROBLEM: Hydraulic fluid viscosity too high.*
   SOLUTION: Ensure hydraulic fluid meets McCoy Drilling & Completions specifications.
   SOLUTION: Ensure hydraulic fluid is appropriate for climatic conditions, especially during cold-weather operation..

9. *POSSIBLE PROBLEM: By-pass valve not functioning.*
   SOLUTION: Check and repair.

D. FAILURE OR DIFFICULTY OF TONG TO SHIFT

1. *POSSIBLE PROBLEM: Bent or broken shifter handle.*
   SOLUTION: Replace shifter handle.

2. *POSSIBLE PROBLEM: Bent or broken shifter yoke.*
   SOLUTION: Inspect and replace shifter yoke.

3. *POSSIBLE PROBLEM: "Frozen" or hard-to-move shifter handle.*
   SOLUTION: Grease shifter shaft.

4. *POSSIBLE PROBLEM: Bent or broken shifter shaft.*
   SOLUTION: Replace.

5. *POSSIBLE PROBLEM: Locking nuts on shifting shaft have loosened and position of yoke has changed.*
   SOLUTION: Reposition yoke and re-tighten locking nuts.

6. *POSSIBLE PROBLEM: Shifting yoke has come loose from shifting shaft*
   SOLUTION: Inspect yoke and inspect for damage. If free of damage, replace on shaft and tighten locking nuts.

7. *POSSIBLE PROBLEM: Tong pops out of gear*
   SOLUTION: Ensure that detent ball & spring assembly has been correctly set.

H. GENERAL COMMENTS

The following factors generally contribute to poor hydraulic operation and premature wear of equipment:

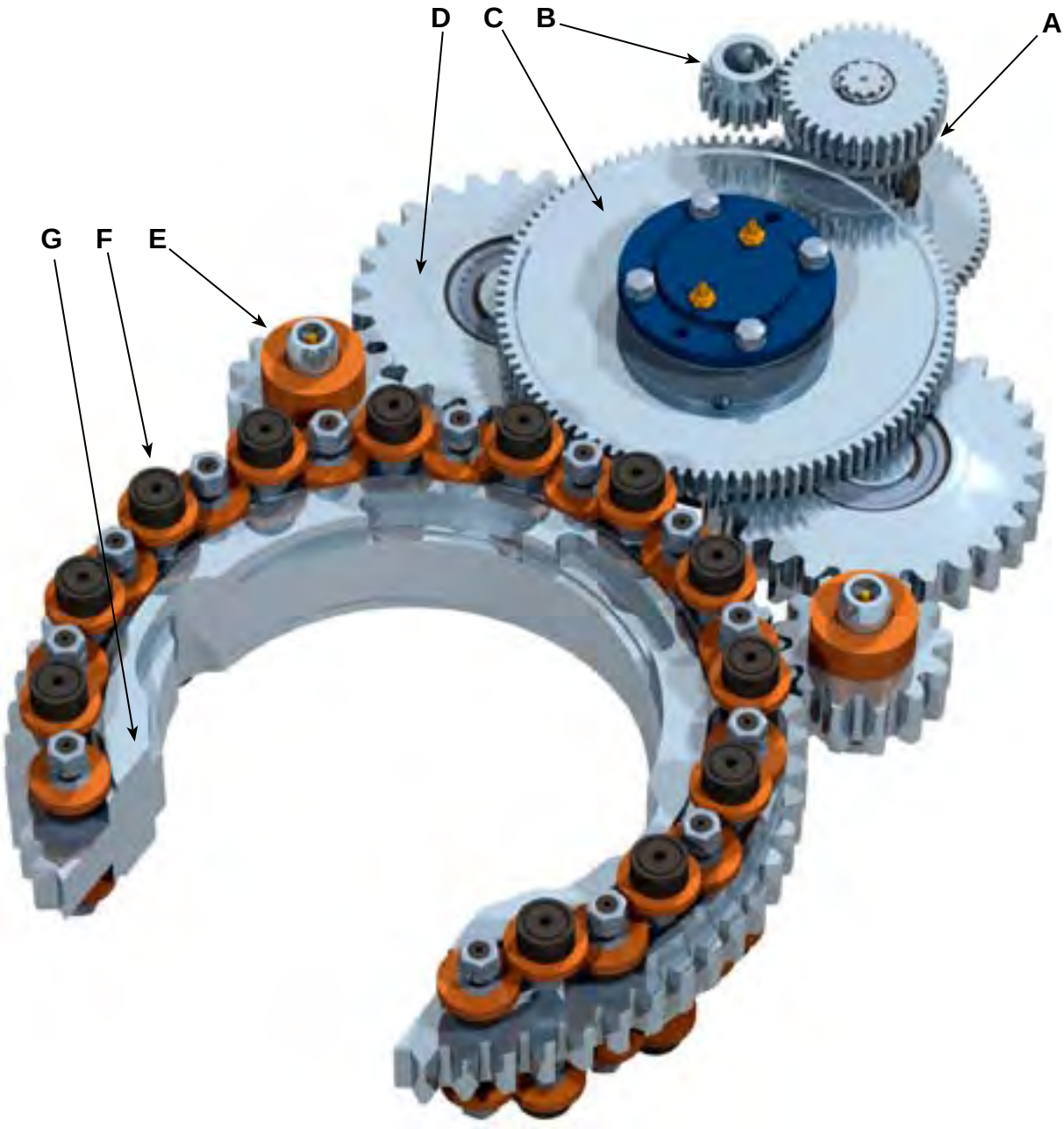
1. *Contaminated hydraulic fluid due to overuse, overheating, or inadequate fluid filtration.*
2. *Unsuitable hydraulic fluid, especially in extreme climatic conditions.*
3. *Defective packing or seals in components of the hydraulic system.*
4. *Poor or incomplete hydraulic system training. Users must be fully qualified to operate the equipment, and have complete understanding of the hydraulic system.*

If your hydraulic troubleshooting procedures involve flow and pressure tests at the power unit, Farr Canada Corp. recommends construction of a test rig that can easily be connected to the main suction and discharge ports of the power unit.

Lightweight 9 5/8" Tong

Model 80-0820-5 Shown

Parts and Assemblies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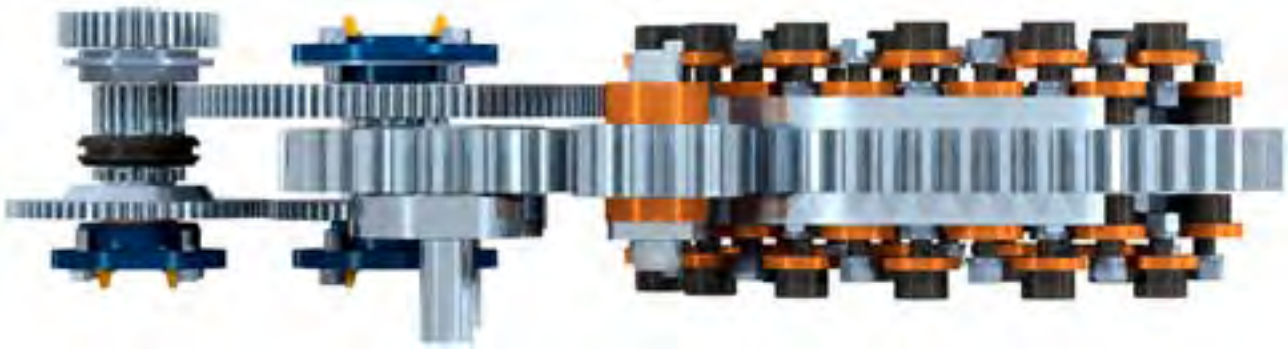
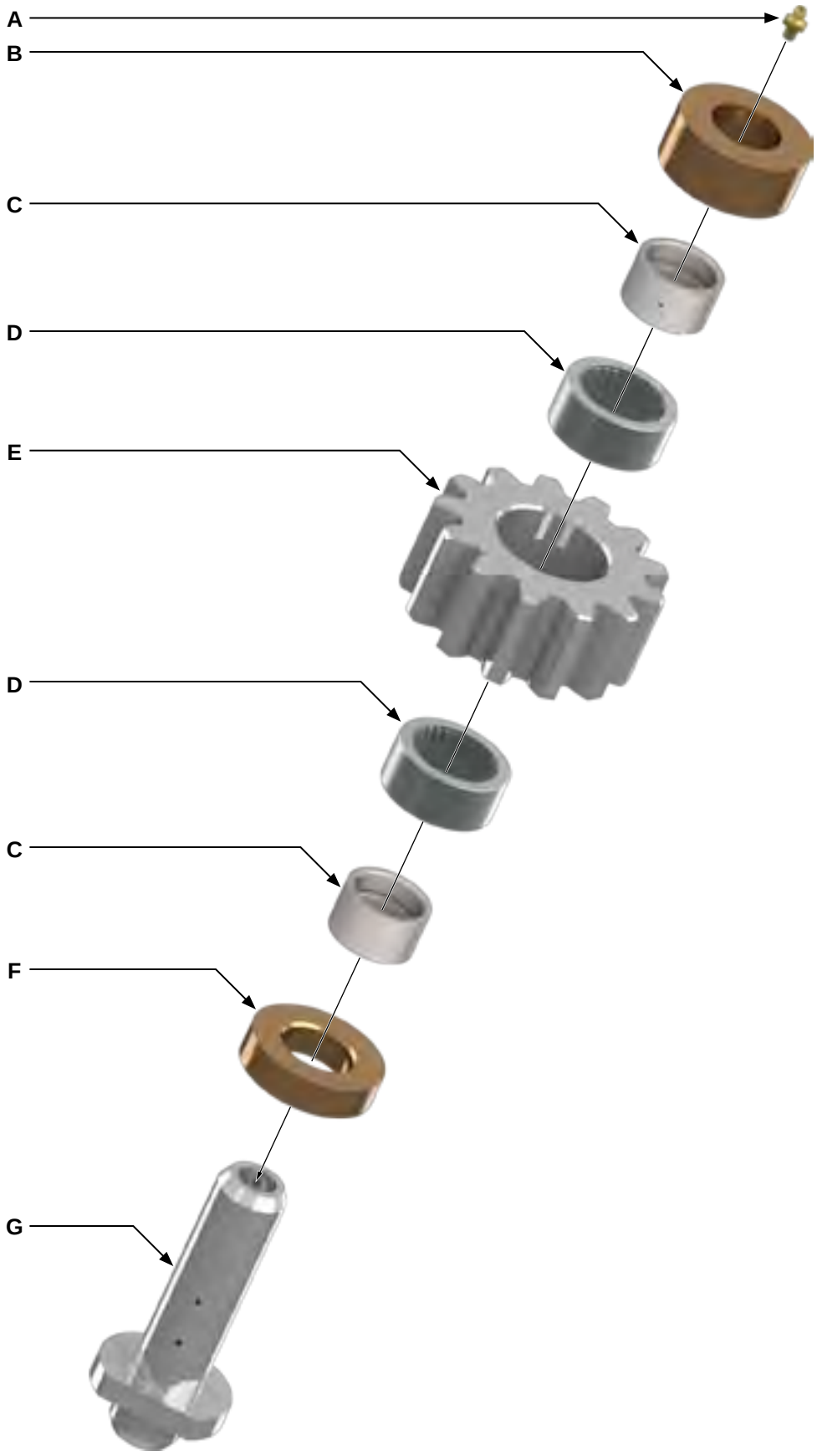
ITEM	TYPE	DESCRIPTION	QTY	PART NUMBER
A	Assembly	Clutch Assembly (See Pp 5.10 - 5.11)	1	101-1469
B	Part	Motor Gear	1	997-A10-149
C	Assembly	Pinion Gear Assembly (See Pp. 5.8 - 5.9)	1	101-1468
D	Assembly	Pinion Idler Assembly (See Pp. 5.6 - 5.7)	2	101-1467
E	Assembly	Rotary Idler Assembly (See Pp. 5.4 - 5.5)	2	101-1466
F	Part	Cam Follower	50	02-0015
	Part	Cam Follower Washer	50	AK03-562
	Part	Cam Follower Spacer (For use inside cage plate grooves)	50	AK03-571
	Part	5/8" Carbon Steel Helical Spring Lock Washer	50	09-5114
	Part	5/8" NC Hex Nut	50	09-5814
G	Part	Rotary Gear	1	AK01-001

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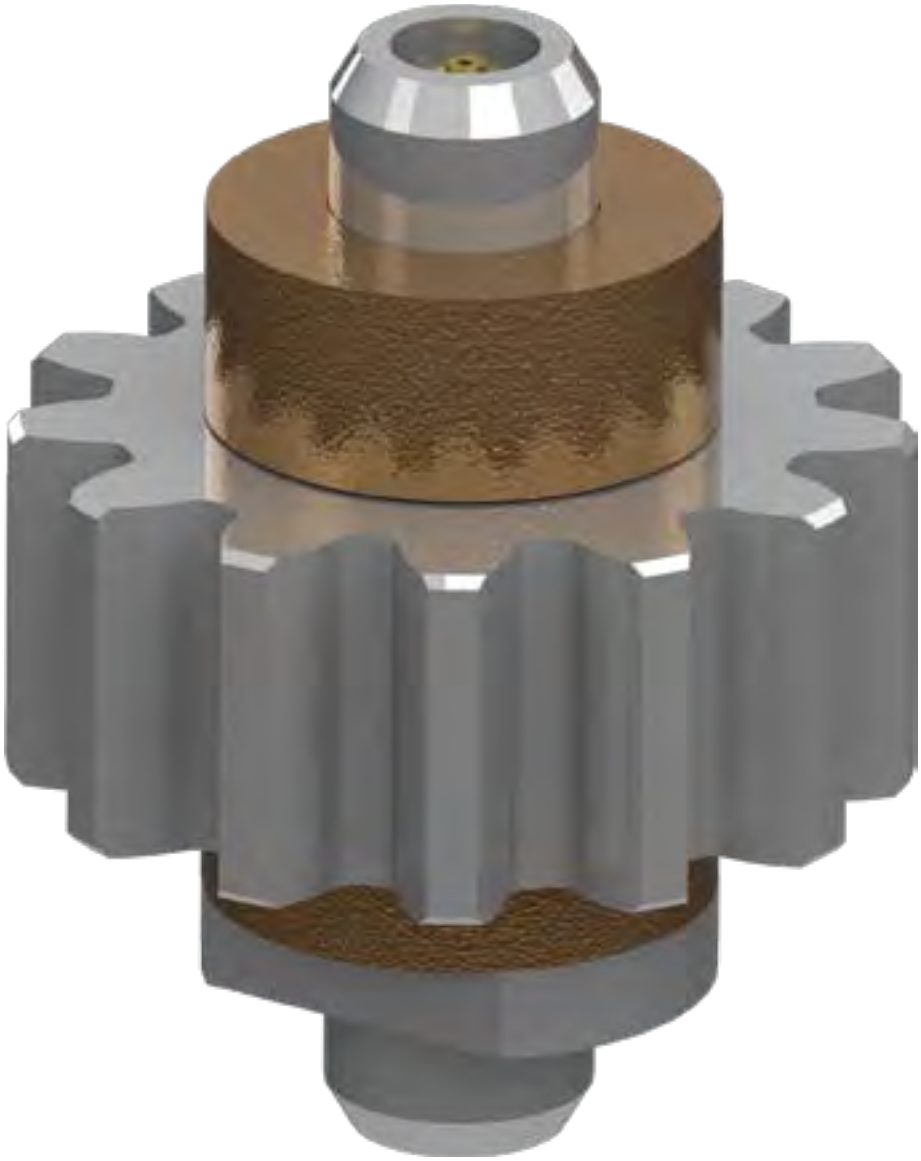
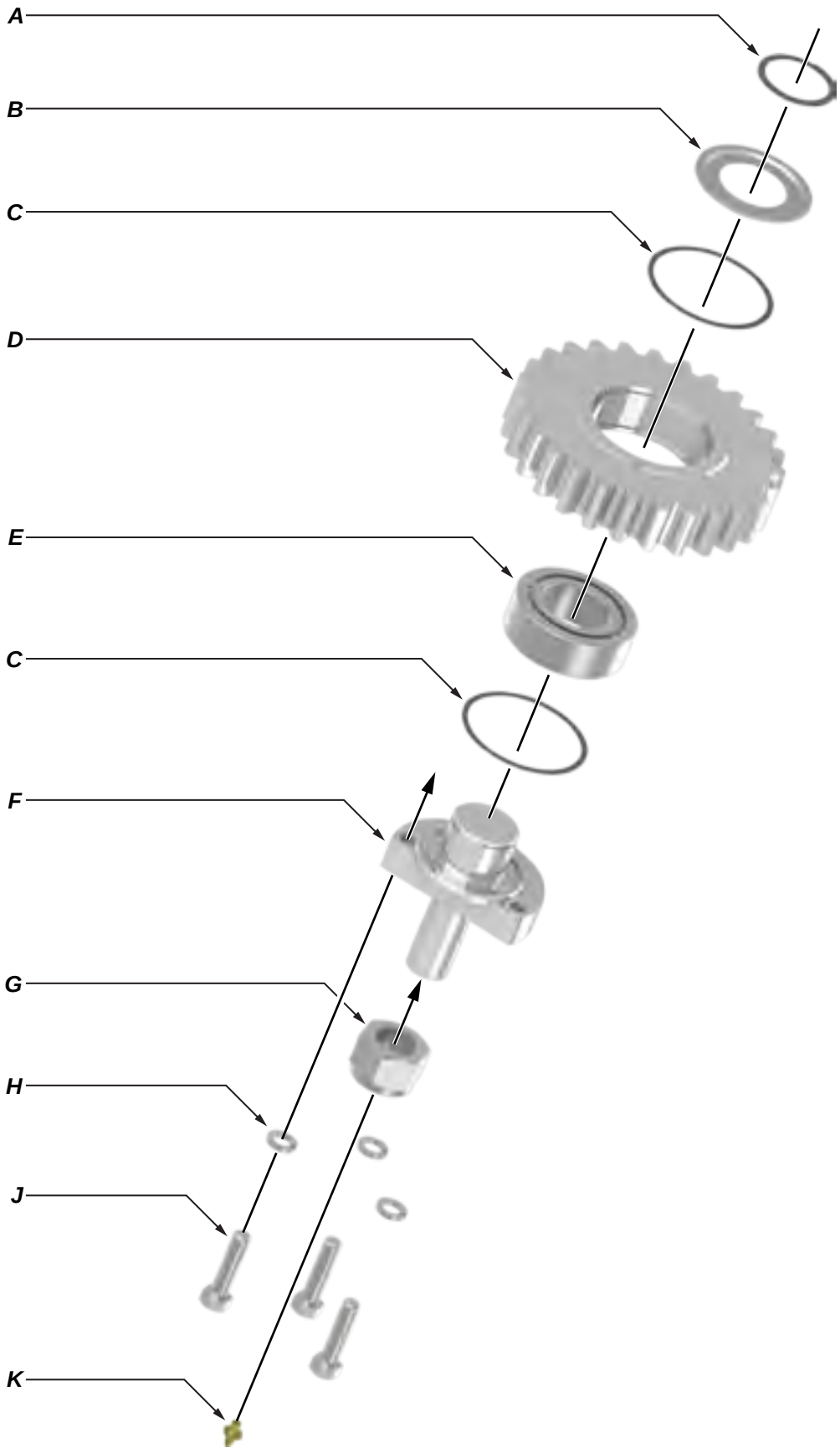


Item	Type	Description	Qty	Part Number
A	Part	Grease Fitting, 1/4" straight thread	1	02-0097
B	Part	Thrust Pad	1	AK01-104
C	Part	Inner Bearing Ring	2	02-0358
D	Part	Needle Bearing	2	02-0361
E	Part	Rotary Idler Gear	1	AK01-102
F	Part	Bottom Rotary Idler Thrust Pad	1	AK01-103
G	Part	Rotary Idler Shaft	1	AK01-101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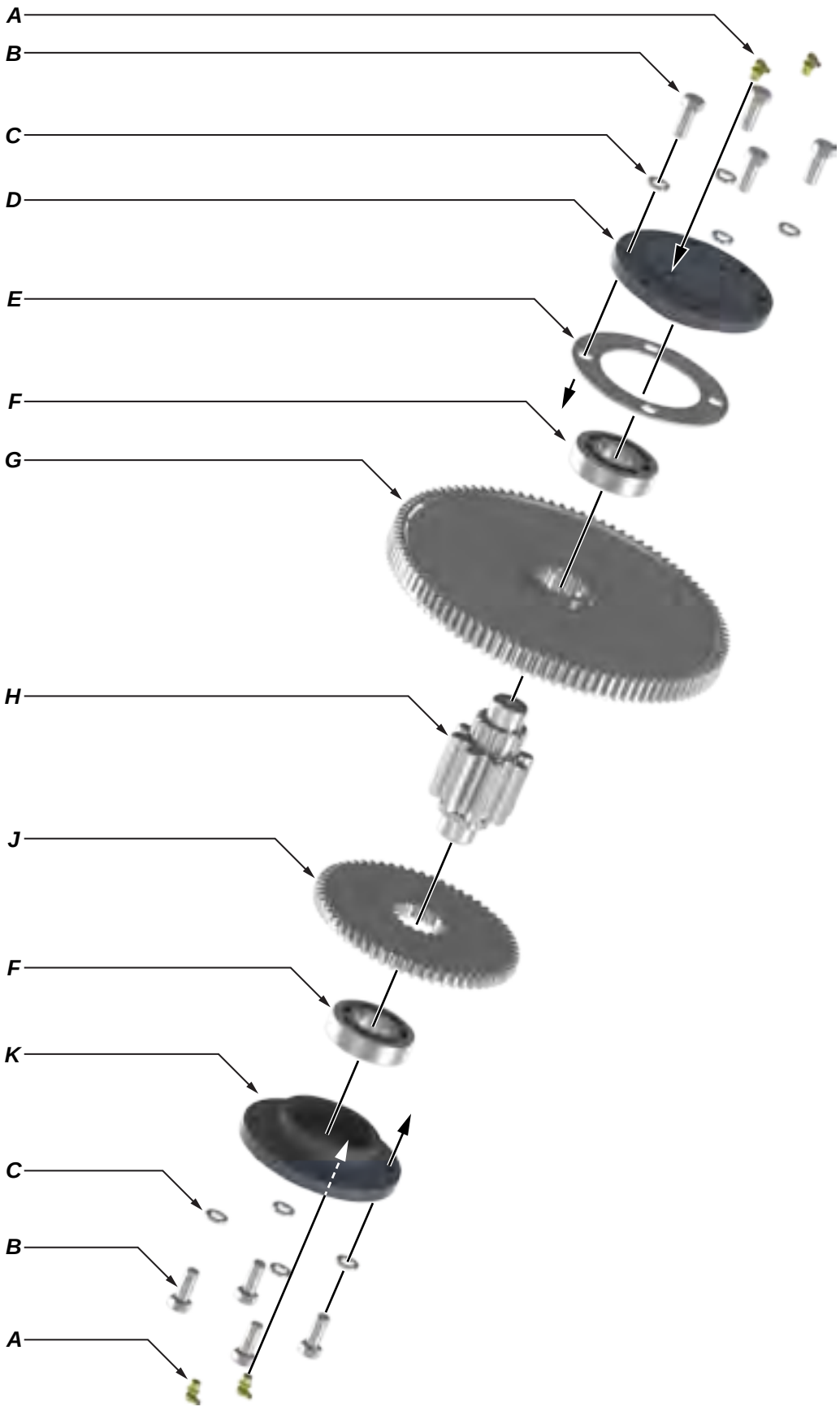
Item	Type	Description	Qty	Part Number
A	Part	Bearing Retainer	1	02-0008
B	Part	Bearing Seal	1	02-0010
C	Part	Gear Retainer	2	02-0009
D	Part	Pinion Idler Gear	1	AK01-122
E	Part	Bearing MU5212TM	1	02-0075
F	Part	Pinion Idler Half Shaft	1	AK01-121
G	Part	1-1/2" Nylock Nut	1	09-5740
H	Part	1/2" Lock Washer	3	09-5110
J	Part	1/2" NC x 2-1/2" Hex Bolt	3	09-1176
K	Part	Grease Fitting, 1/8" NPT	1	02-0005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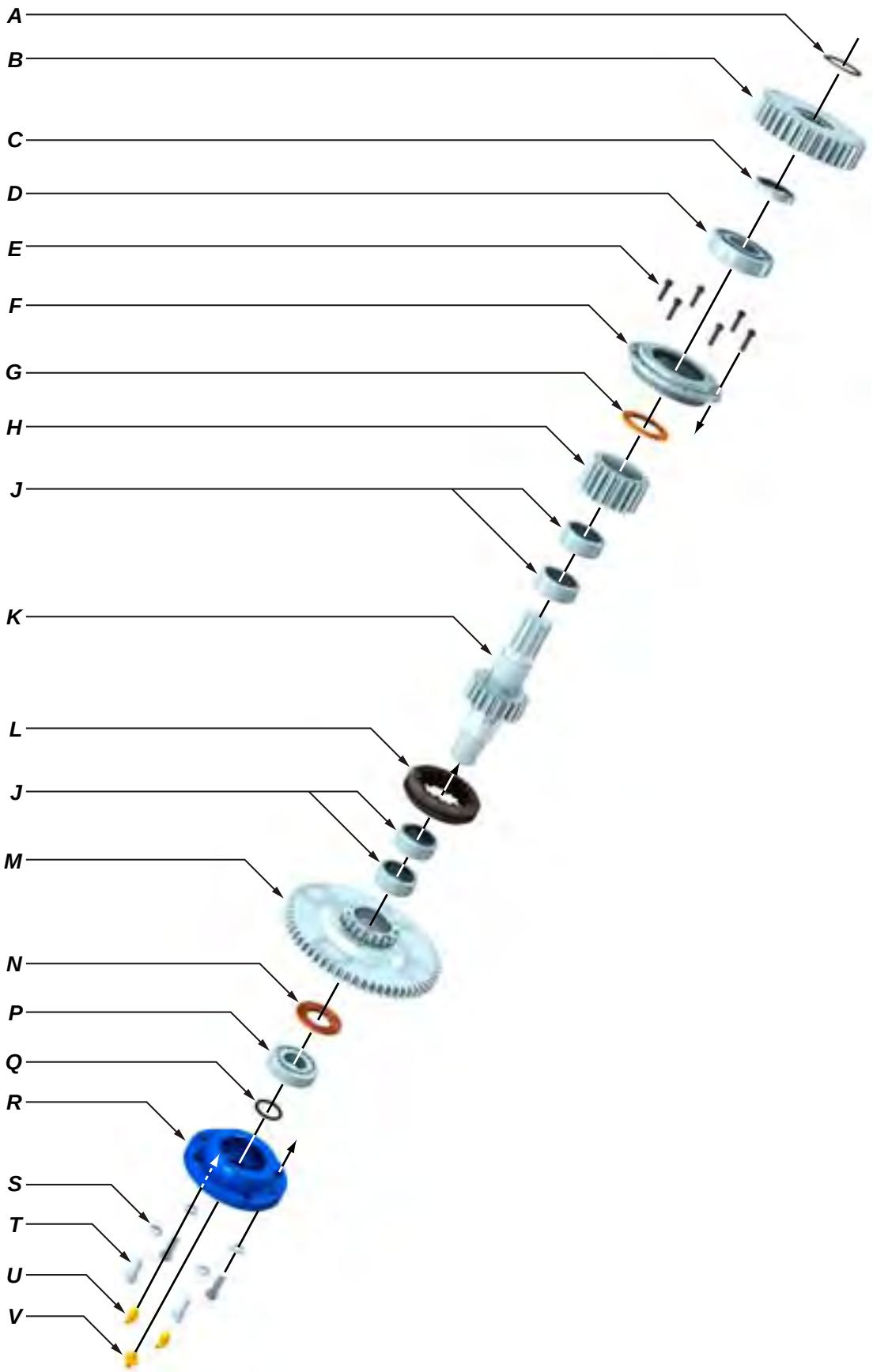
Item	Type	Description	Qty	Part Number
A	Part	1/8" NPT 90 DEG Grease Fitting	4	02-0093
B	Part	1/2" UNC x 1-1/4" Hex Bolt	8	09-1168
C	Part	1/2" Lock Washer	8	09-5110
D	Part	Top Pinion Bearing Cap	1	997-D15-89
E	Part	Pinion Bearing Spacer	1	1400-89A
F	Part	Cylindrical Roller Bearing	2	1234-08-01B
G	Part	Low Pinion Gear	1	997-A5-88
H	Part	Pinion Gear Shaft	1	997-A7-86B
J	Part	High Pinion Gear	1	997-A4-87B
K	Part	Bottom Pinion Bearing Cap	1	AK01-151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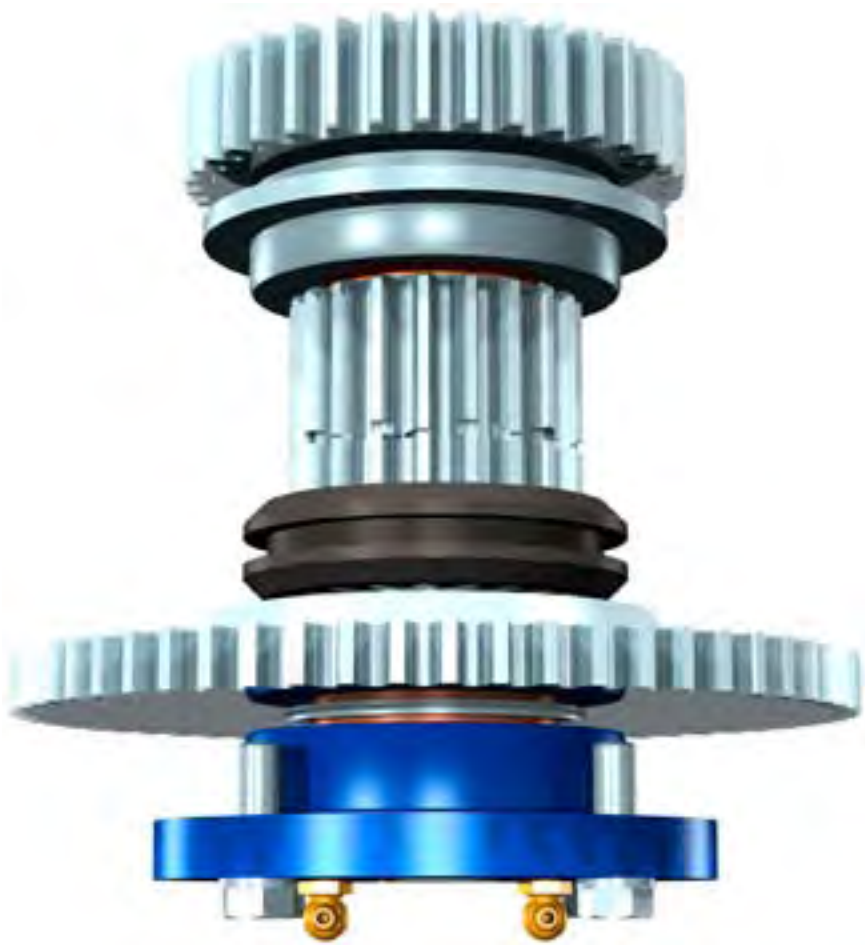
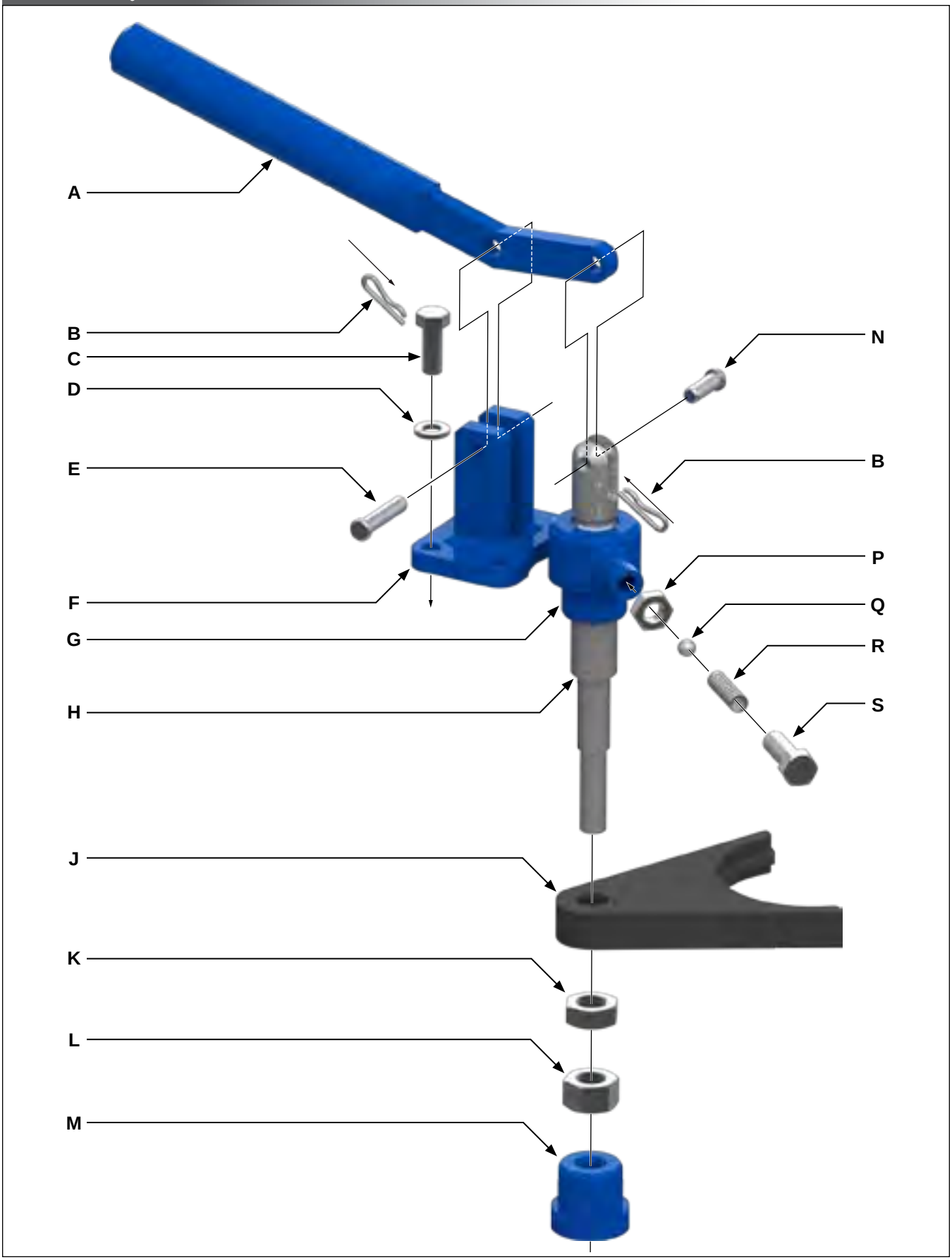


Item	Type	Description	Qty	Part Number
A	Part	Outside Snap Ring	1	1234-00-04
B	Part	Drive Gear	1	997-HT-61
C	Part	Top Clutch Spacer	1	AK01-205
D	Part	Top Clutch Bearing	1	02-0077
E	Part	#10 x 3/4" Hex SHCS	6	09-0001
F	Part	Top Bearing Retainer	1	AK01-203
G	Part	Top Clutch Bearing Spacer	1	AK01-204
H	Part	Low Clutch Gear	1	997-HT-52
J	Part	Needle Roller Bearing	4	02-1404
K	Part	Splined Clutch Shaft	1	AK01-202
L	Part	Shifting Collar	1	997-HT-62
M	Part	High Clutch Gear	1	997-HT-51B
N	Part	Bottom Clutch Spacer	1	997-99
P	Part	Bottom Clutch Bearing	1	02-0076
Q	Part	Clutch O-Ring	1	08-1240
R	Part	Clutch Bearing Cap	1	AK01-201
S	Part	3/8" Lock Washer	4	09-5106
T	Part	3/8" NC x 1-1/4" Hex Bolt	4	09-1048
U	Part	1/8" NPT 90° Grease Fitting	2	02-0093
V	Part	1/8" NPT Grease Fitting	1	02-0005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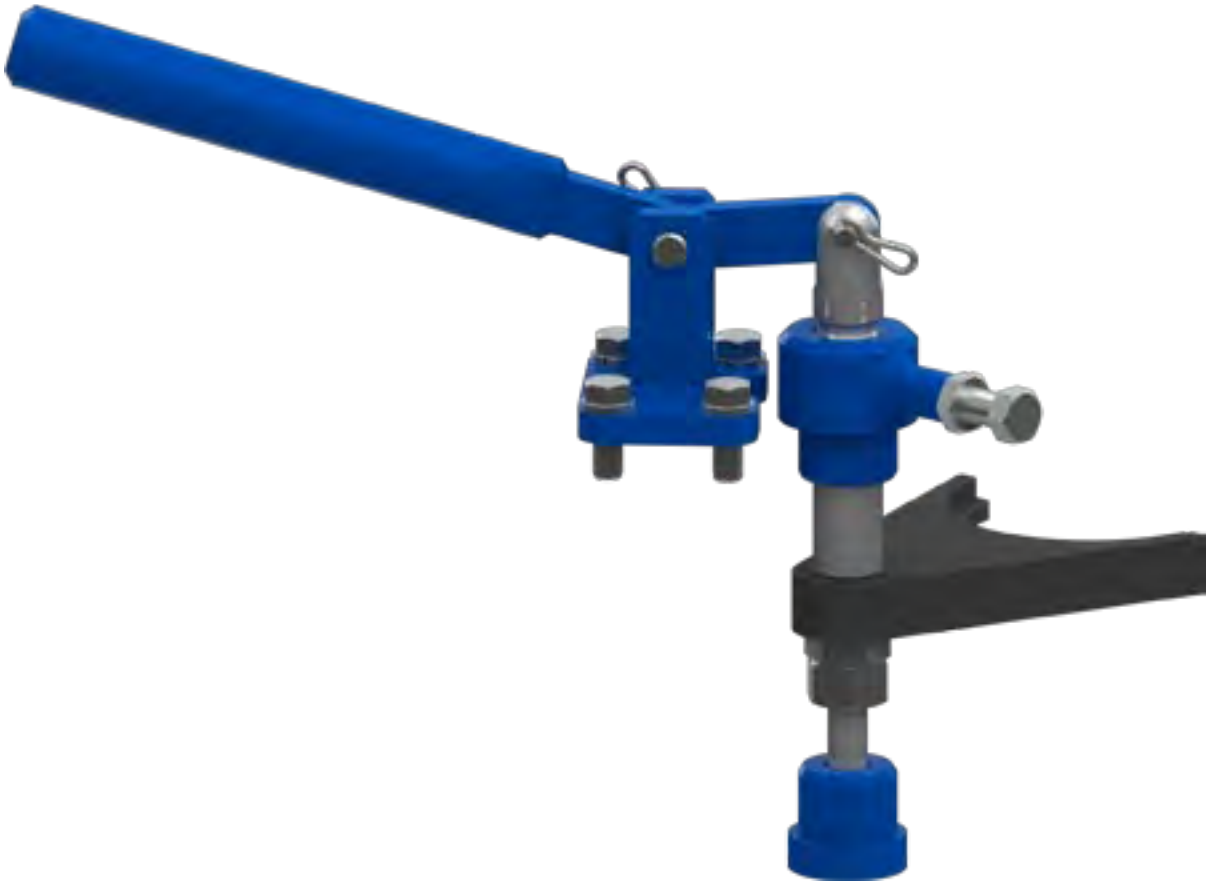
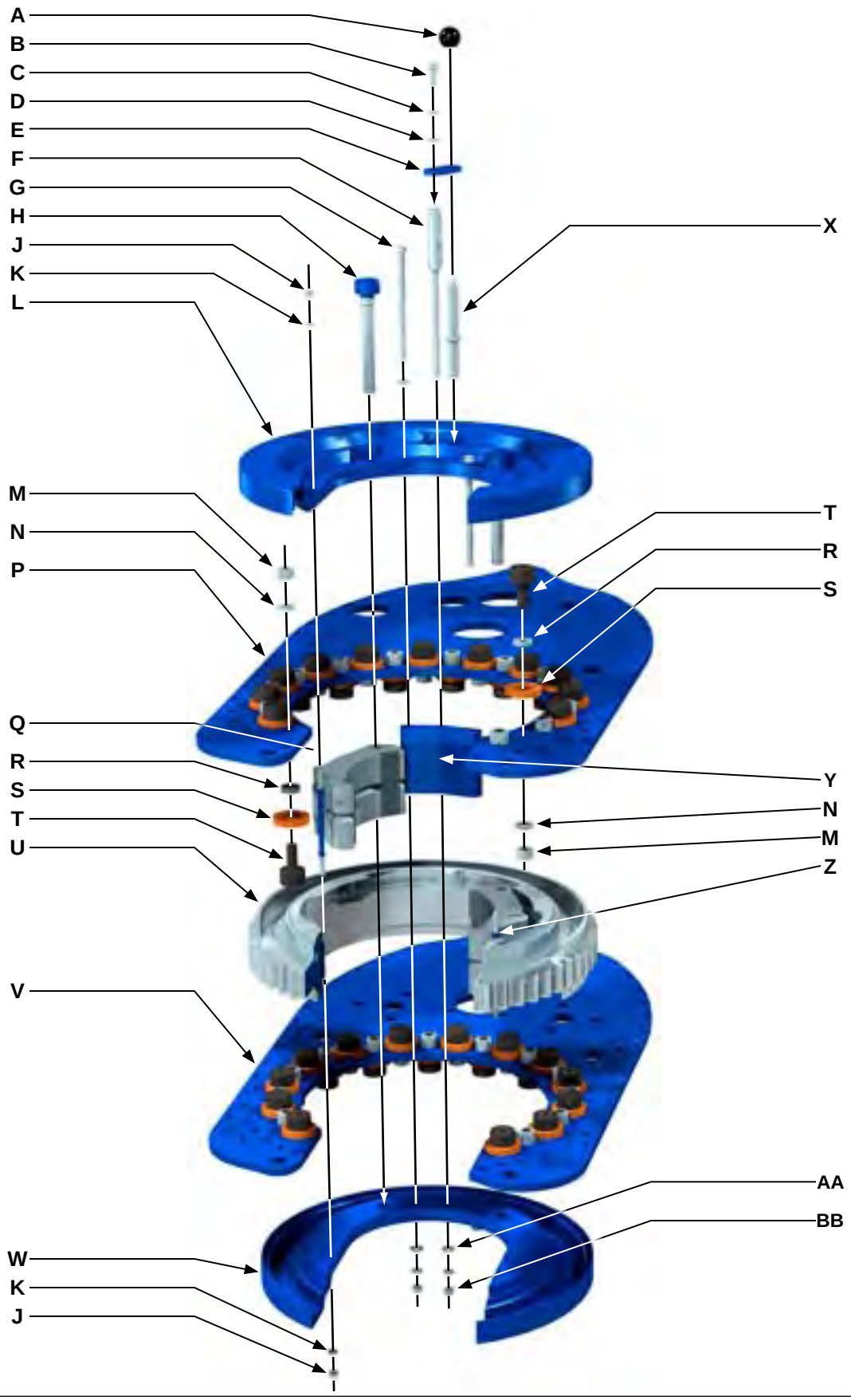


Item	Type	Description	Qty	Part Number
A	Weldment	Shifting Handle Weldment	1	AK00-092
B	Part	HITCH PIN .0930 X 1.125	2	02-0274
C	Part	3/8" NC x 1" Hex Bolt	4	09-1046
D	Part	3/8" Lock Washer	4	09-5106
E	Part	5/16" x 1-1/2" Clevis Pin	1	09-0256
F	Weldment	Shifter Lug Weldment (Bolted)	1	101-0016
G	Weldment	Top Shifter Bushing (typically welded to top plate)	1	1064-B1-94
H	Part	Shifting Shaft	1	1400-71
J	Part	Shifting Fork	1	997-HT-72
K	Part	5/8" UNF Hex Jam Nut	1	09-5915
L	Part	5/8" UNF Hex Nut	1	09-5914
M	Part	Lower Shifter Bushing (typically welded to bottom plate)	1	AK00-091
N	Part	5/16" x 1" Clevis Pin	1	02-0020
P	Part	7/16" UNF Hex Jam Nut	1	09-5508
Q	Part	Detent Ball	1	02-0018
R	Part	Detent Spring	1	997-0-64
S	Part	7/16" UNF x 1-1/4" Hex Bolt	1	09-1608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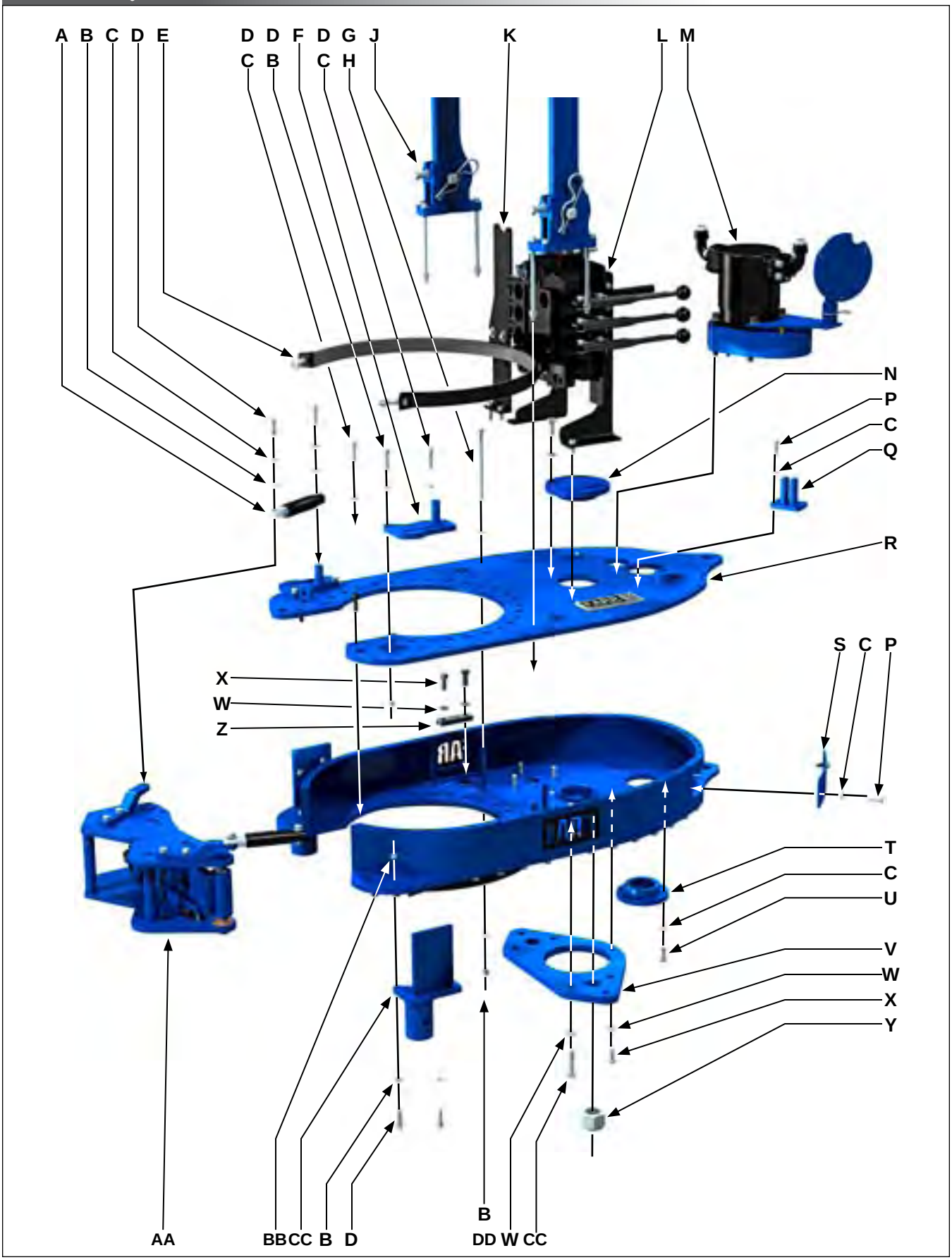
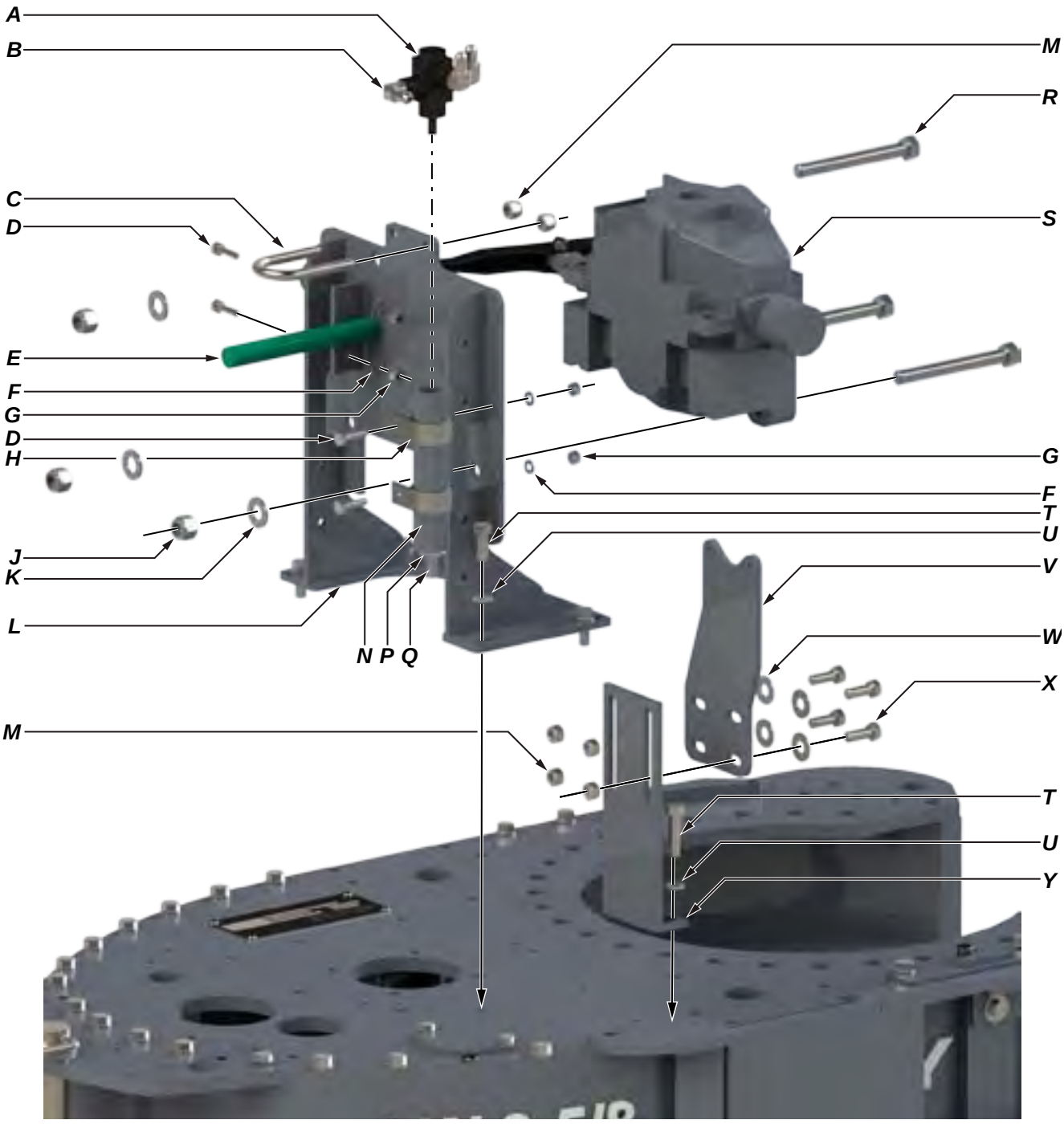
Item	Type	Description	Qty	Part Number
A	Part	Knob	1	02-0017
B	Part	3/8" NC x 1" Hex Bolt	1	09-1046
C	Part	3/8" Lock Washer	1	09-5106
D	Part	3/8" Narrow Flat Washer	6	09-5006
E	Part	Retainer	1	AK20-034
F	Part	Rear Cage Plate Bolt	1	AK20-033
G	Part	3/8" NC x 6-1/2" Hex Bolt	2	09-1252
H	Part	Jaw Pivot Bolt	2	AK10-056
J	Part	5/16" Nylock Nut	8	09-5703
K	Part	5/16" Flat Washer	8	09-5004
L	Part	Cage Plate - TOP	1	AK20-010
M	Part	5/8" UNF Hex Jam Nut	50	09-5514
N	Part	5/8" Lock Washer	50	09-5114
P	Part	Top Plate (shown for illustration purposes only)	1	AK07-002
Q	Assembly	Jaw Die Kit (8-5/8" shown - see Pg. 2.8)	2	
R	Part	Cam Follower Spacer-Washer	50	AK03-571
S	Part	Cam Follower Washer	50	AK03-572
T	Part	Cam Follower	50	02-0015
U	Part	Rotary Gear	1	AK01-001
V	Part	Bottom Plate (shown for illustration purposes only)	1	AK07-001
W	Weldment	Bottom Cage Plate Weldment	1	AK20-20W
X	Part	Backing Pin	1	AK20-036
Y	Part	Rear Cage Plate Spacer	1	AK20-032
Z	Part	Front Cage Plate Spacer	2	AK20-031
AA	Part	3/8" Narrow Flat Washer	3	09-5124
BB	Part	3/8" Nylock Nut	3	09-5607



Item	Type	Description	Qty	Part Number
A	Assembly	Door Stop Cylinder Assembly	2	101-0069
B	Part	3/8" Narrow Flat Washer	12	09-5124
C	Part	3/8" Lock washer	69	09-5106
D	Part	3/8" NC x 1-1/2" Hex Bolt	53	09-1553
E	Weldment	Lined Brake band Weldment (See Pp. 5.22 - 5.23)	2	AK29-001
F	Weldment	LH Leg Support Plate Weldment (Backup-Ready Only)	1	101-2072
	Weldment	RH Leg Support Plate Weldment (Backup-Ready Only)	1	101-2070
	Weldment	LH Rear Door Cylinder Weldment (Stand-Alone Tong)	1	AK12-030
	Weldment	RH Rear Door Cylinder Weldment (Stand-Alone Tong)	1	AK12-030RH
G	Part	3/8" NC x 6" Hex Bolt	2	09-1070
H	Part	3/8" Narrow Flat Washer	12	09-5124
J	Assembly	Rigid Sling Assembly (See Pp. 5.28 - 5.29)	1	
K	Assembly	Hydraulic Valve Support Assembly (See Pp. 5.18 - 5.19)	1	
L	Assembly	Hydraulic Valve Assembly (See Pp. 5.18 - 5.19)	1	
M	Assembly	Motor & Motor Mount Assembly (See Pp. 5.20 - 5.21)	1	
N	Part	Top Pinion Bearing Cap (See Pp. 5.8 - 5.9)	1	997-D15-89
P	Part	3/8" NC x 1" Hex Bolt	6	09-1046
Q	Weldment	Shifter Lug Weldment	1	101-0016
R	Part	Body Plate - TOP	1	AK07-002
S	Part	Clutch Access Plate	1	AK00-006
T	Part	Clutch Bearing Cap	1	AK01-201
U	Part	3/8" NC x 1-1/4" Hex Bolt	4	09-1048
V	Part	Stiffener Plate	1	AK00-001
W	Part	1/2" Lock Washer	7	09-5110
X	Part	1/2" NC x 1-1/4" Hex Bolt	1	09-1168
Y	Part	1-1/2" UNF Nylock Nut	2	09-5740
Z	Part	Idler Restraint Block	2	AK00-003
AA	Assembly	Door Assembly (See Pp. 5.24 - 5.27)	1	
BB	Part	3/8" NC Nylock Nut	6	09-5607
CC	Weldment	LH Front Leg Mount Weldment (Backup-Ready Only)	1	101-2069
	Weldment	RH Front Leg Mount Weldment (Backup Ready Only)	1	101-2067
	Weldment	LH Front Leg Weldment (Stand-Alone Tong)	1	101-1676
	Weldment	RH Front Leg Weldment (Stand-Alone Tong)	1	101-1675
	Weldment	LH Rear Leg Weldment (Stand-Alone Tong)	1	101-1677
	Weldment	RH Rear Leg Weldment (Stand-Alone Tong)	1	101-1678
DD	Part	1/2" NC x 2-1/2" Hex Bolt	6	09-1176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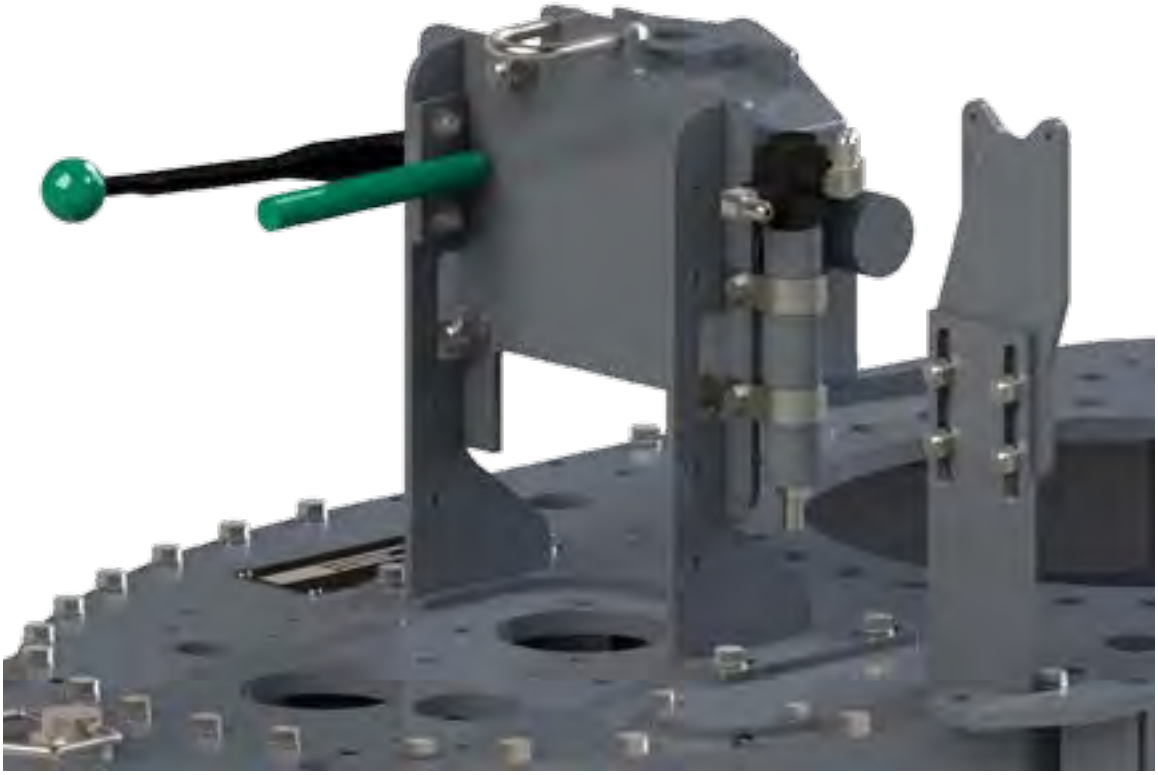
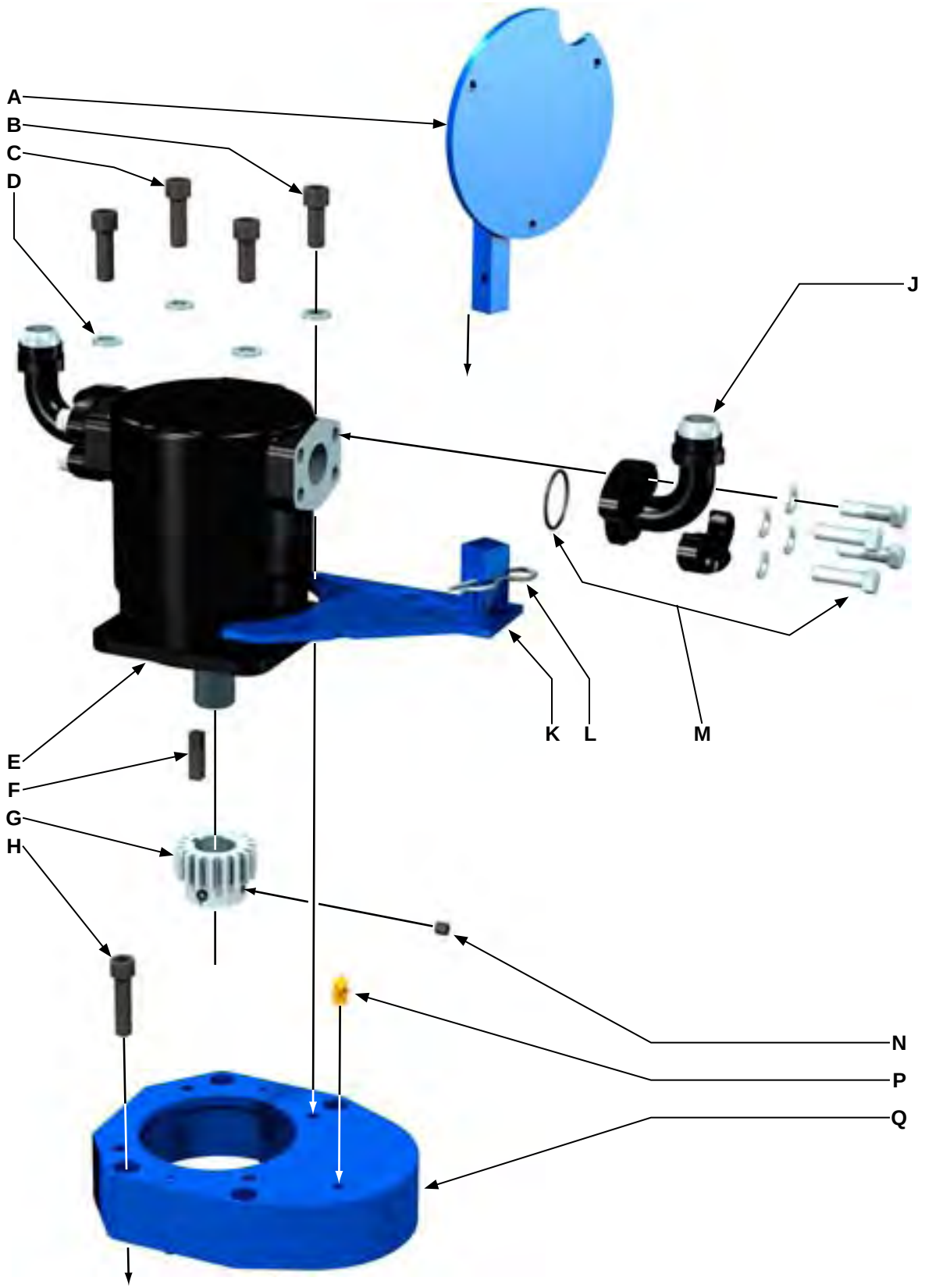


Item	Type	Description	Qty	Part Number
A	Part	Deltrol Safety Door Valve	1	08-0337M
B	Part	1/4" NPT - JIC 90° Elbow	3	08-0284
C	Part	Threaded U-Bolt	1	101-2075
D	Part	1/4" UNC x 1" Hex Bolt	4	09-1007
E	Weldment	Handle Weldment	1	AK00-076
F	Part	1/4" Narrow Flat Washer	4	09-5002
G	Part	1/4" UNC Nylock Nut	4	09-5701
H	Part	Bracket	2	02-E0025
J	Part	1/2" UNC Nylock Nut	3	09-5610
K	Part	1/2" Narrow Flat Washer	3	09-5119
L	Weldment	Valve Mount Weldment	1	AK00-070
M	Part	3/8" UNC Nylock Nut	6	09-5607
N	Part	Cable Guide Holder	1	101-4236
P	Part	7/16" UNF Hex Jam Nut	1	09-5508
Q	Part	Safety Door Mechanical Cable (Shown for illustration purposes only)	1	
R	Part	1/2" NC x 4-1/2" Hex Bolt	3	09-1184
S	Assembly	Hydraulic Valve Assembly	1	See Pg. 2.7
T	Part	3/8" UNC x 1-1/4" Hex Bolt	6	09-1048
U	Part	3/8" Lock Washer	6	09-5106
V	Part	Hydraulic Support Plate	1	101-1583
W	Part	3/8" Flat Washer	4	09-5006
X	Part	3/8" NC x 1" Hex Bolt	4	09-1046
Y	Weldment	Inlet Coupling Support Weldment	1	101-1138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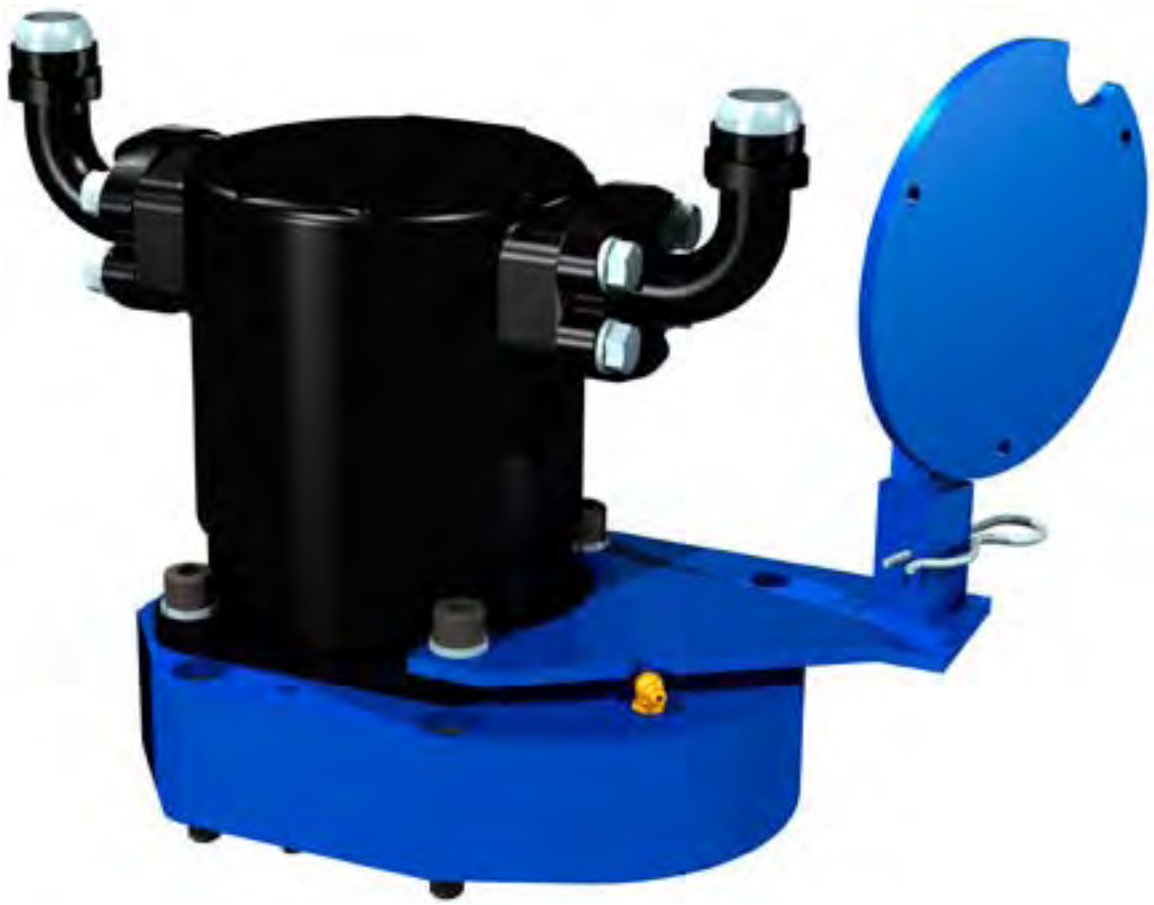
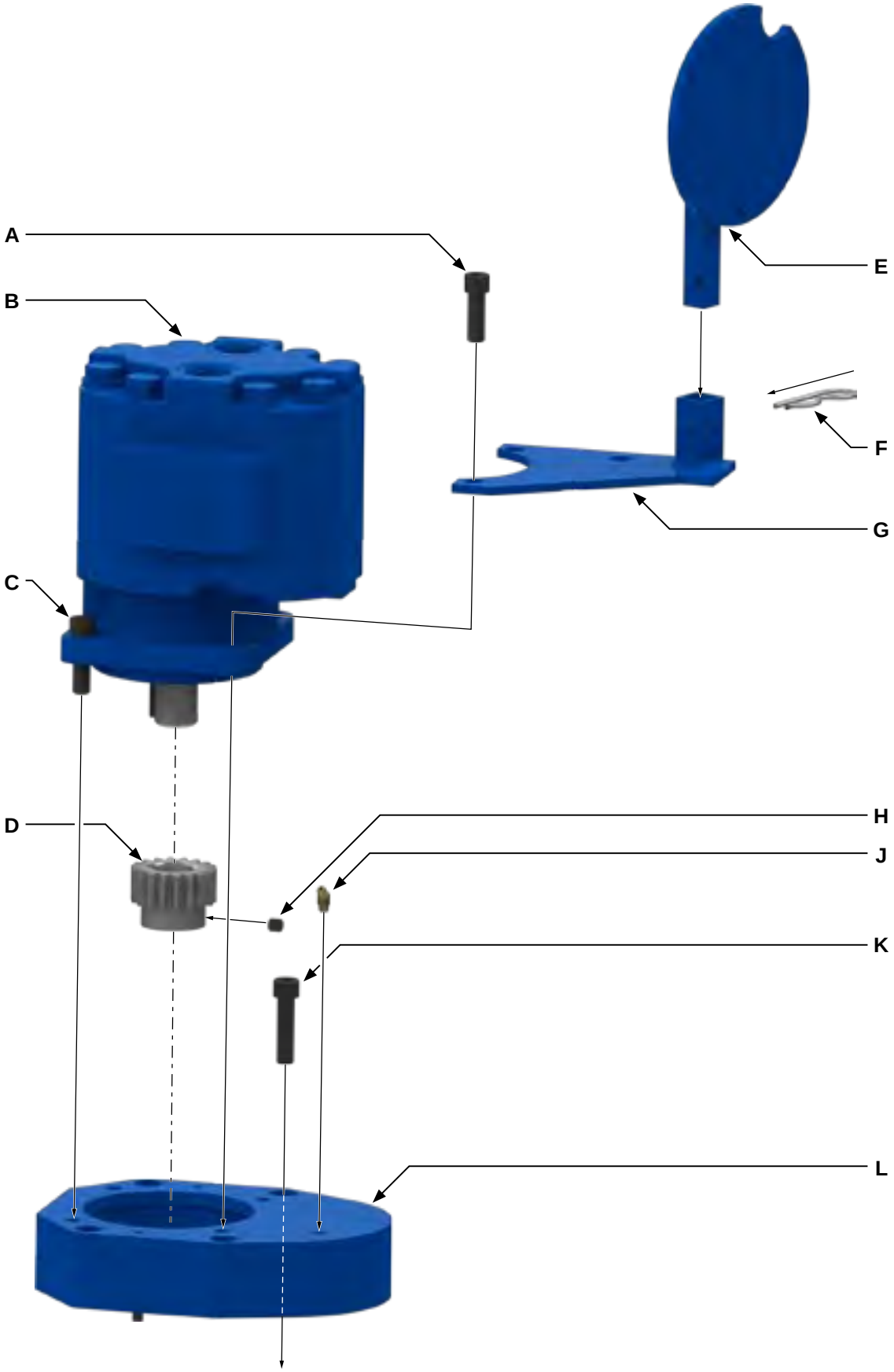


Item	Type	Description	Qty	Part Number
A	Weldment	Torque Gauge Mount Weldment	1	1500-09-03A
B	Part	1/2" NC x 1-1/4" Hex Socket Head Cap Screw	2	09-2168
C	Part	1/2" NC x 1-1/2" Hex Socket Head Cap Screw	2	09-2170
D	Part	1/2" Lock Washer	4	09-5110
E	Part	Rineer GA15-9.5 Hydraulic Motor	1	87-0109
F	Part	3/8" x 3/8" x 1-1/2" Square Gear Key	1	01-0317
G	Part	Motor Gear	1	997-A10-149
H	Part	1/2" NC x 2" Hex Socket Head Cap Screw	4	09-0234
J	Part	#20 (1-1/4")/JIC 1" Flange Elbow	2	02-9216
K	Weldment	Torque Gauge Holder Weldment	1	1500-09-04A
L	Part	0.148" x 2.938" Hitch Pin	1	09-0090
M	Part	#20 (1-1/4") Split Flange Kit	2	02-9217
	Part	O-Ring	1	
	Part	#20 (1-1/4") Split Flange	2	
	Part	7/16" Lock Washer	4	
	Part	7/16" NC x 1-1/2" Hex Bolt	4	
N	Part	3/8" NC x 3/8" Hex Socket Set Screw	2	09-0106
P	Part	1/8" NPT 90° Grease Fitting	1	02-0093
Q	Part	Motor Mount	1	997-A10-149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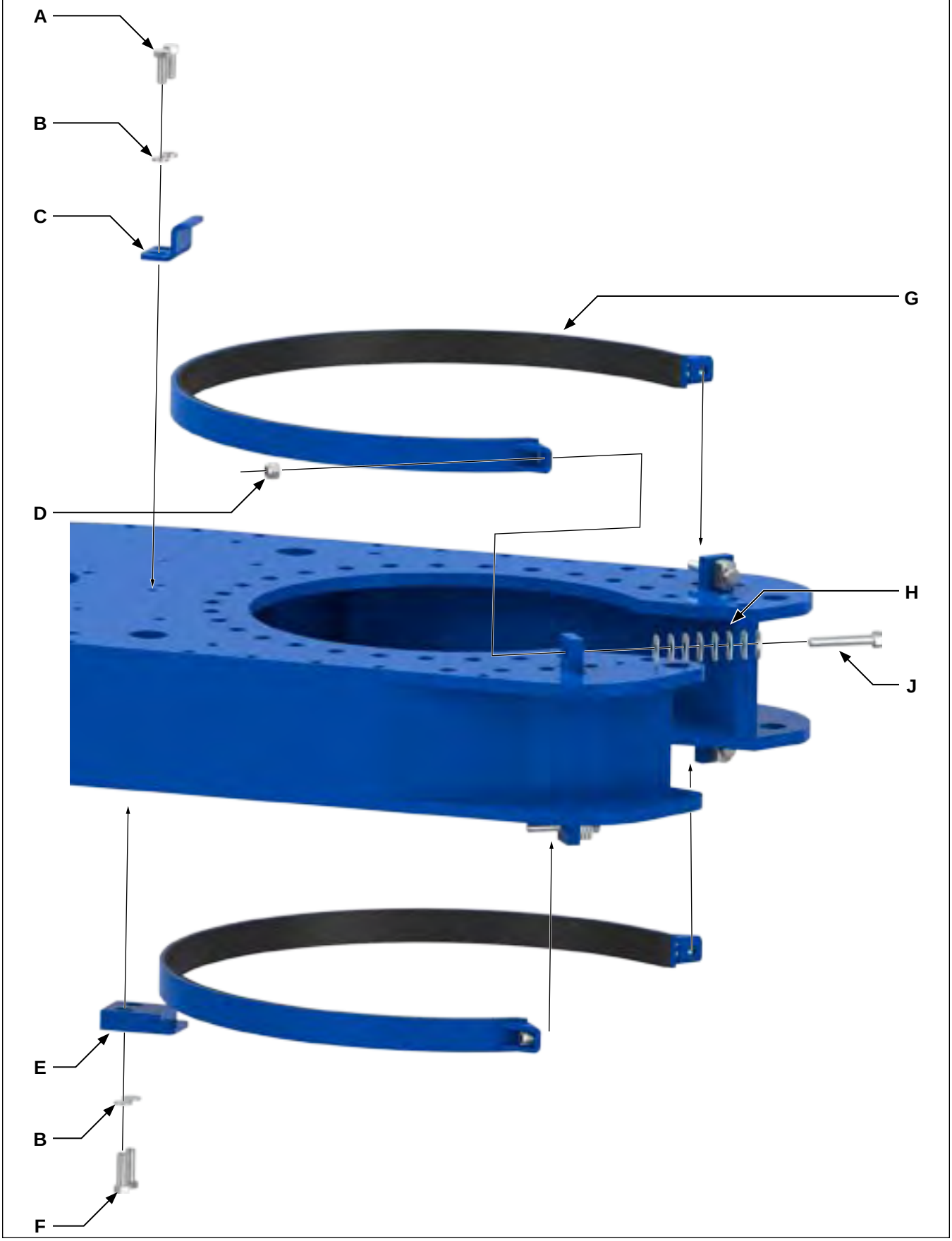
Item	Type	Description	Qty	Part Number
A	Part	1/2" NC x 1-1/2" Hex Socket Head Cap Screw	2	09-2170
B	Part	Commercial M77 Hydraulic Motor	1	87-0070
C	Part	1/2" NC x 1-1/4" Hex Socket Head Cap Screw	2	09-2168
D	Part	Motor Gear	1	997-A10-149
	Part	5/16" x 5/16" x 1-1/2" Square Gear Key	1	01-0317
E	Weldment	Torque Gauge Mount Weldment	1	1500-09-03A
F	Part	0.148" x 2.938" Hitch Pin	1	09-0090
G	Weldment	Torque Gauge Holder Weldment	1	1500-09-04A
H	Part	3/8" NC x 3/8" Hex Socket Set Screw	2	09-0106
J	Part	1/8" NPT 90° Grease Fitting	1	02-0093
K	Part	1/2" NC x 2" Hex Socket Head Cap Screw	2	09-0234
L	Part	Motor Mount	1	1064-C8-150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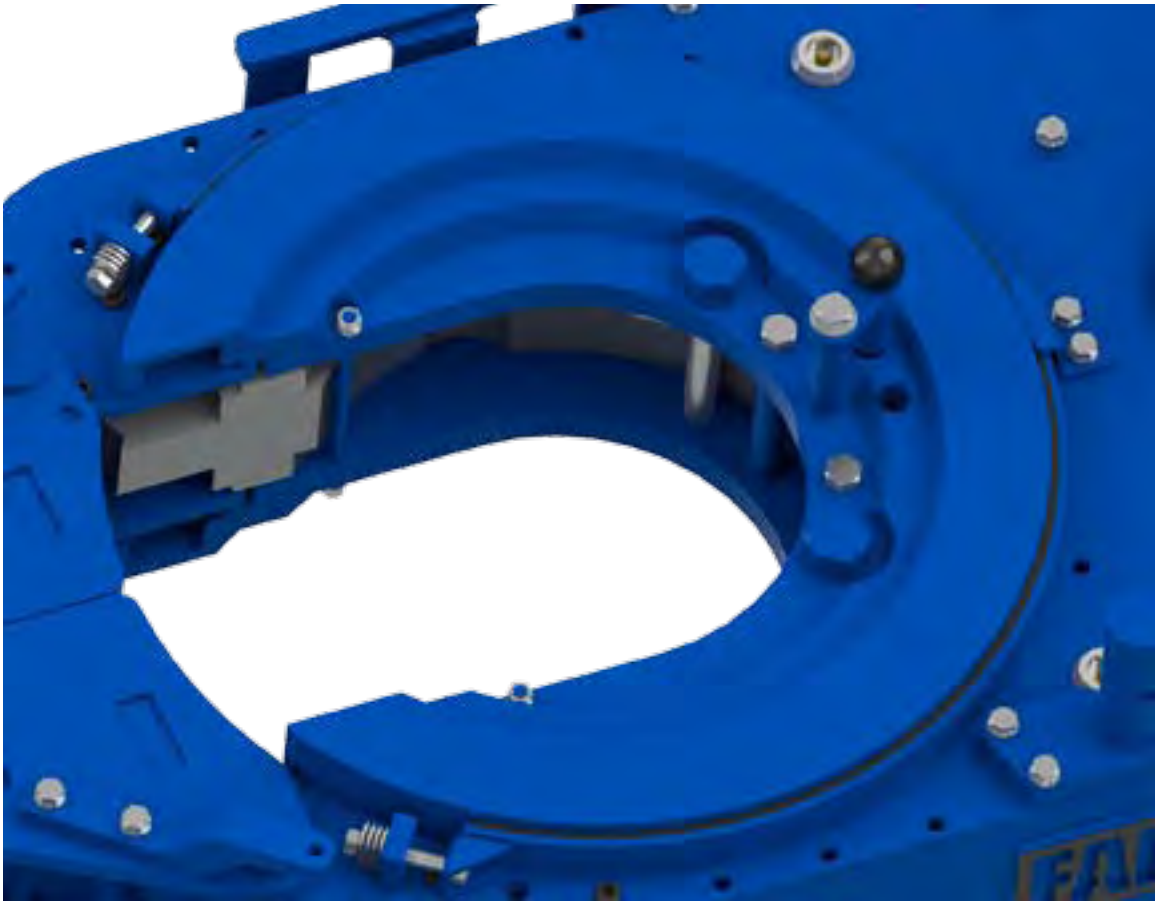
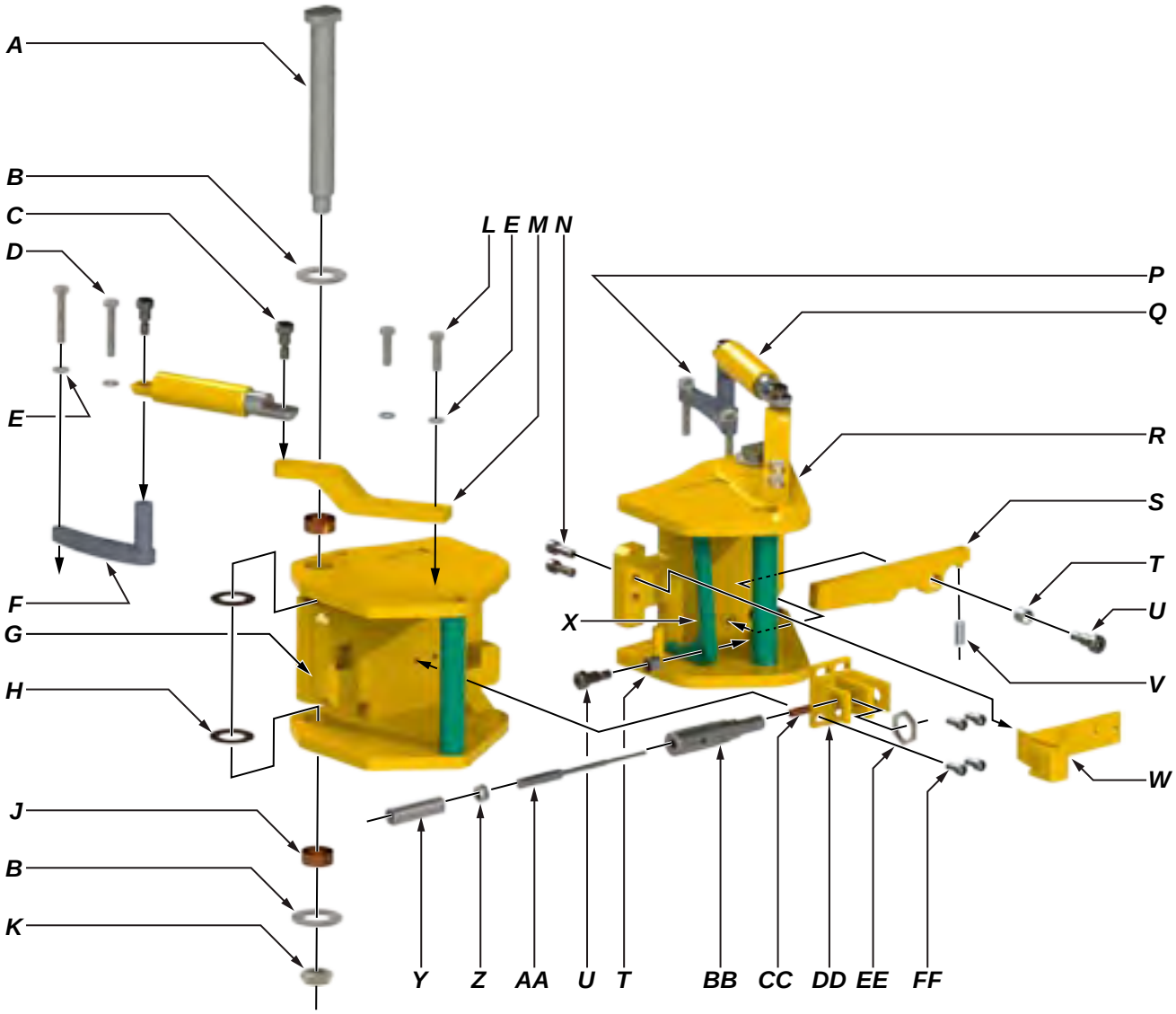


Item	Type	Description	Qty	Part Number
A	Part	3/8" NC x 1" Hex Cap Screw	2	09-1046
B	Part	3/8" Lock Washer	4	09-5106
C	Part	Brake Band Retainer (Top)	1	101-1858
D	Part	3/8" UNC Hex Nylock Nut	4	09-5607
E	Part	Brake Band Retainer (Bottom)	1	101-2360
F	Part	3/8" NC x 1-1/4" Hex Cap Screw	2	09-1048
G	Weldment	Lined Brake Band Weldment	2	AK29-001
H	Assembly	Belleville Washer (8 per set)	4	101-3272ASSEM
J	Part	3/8" NC x 2-1/2" Hex Cap Screw	4	09-1056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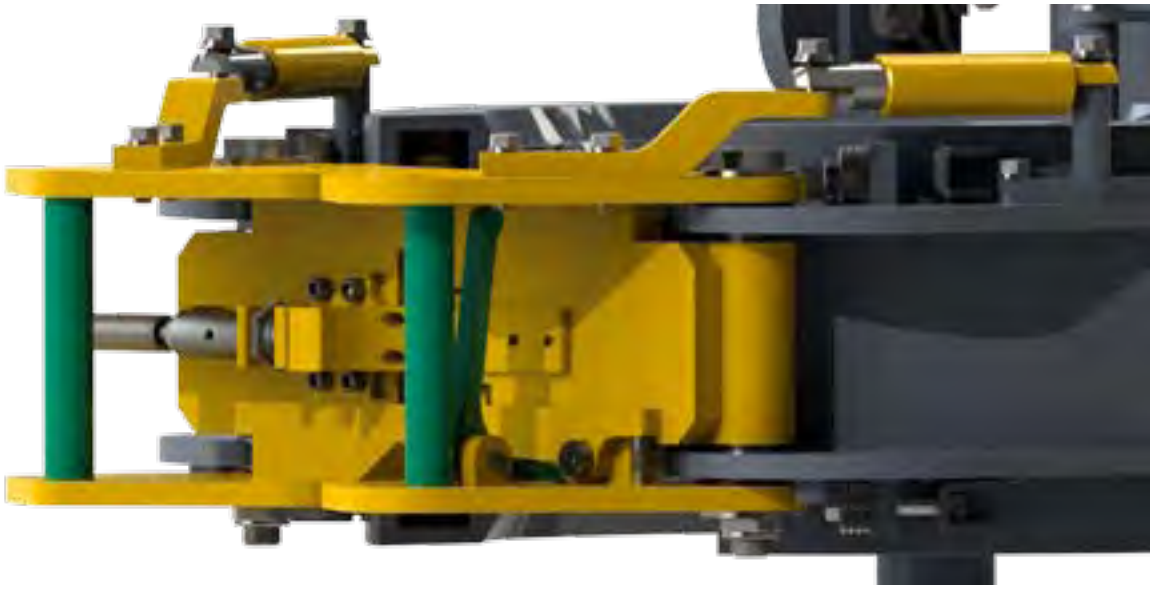
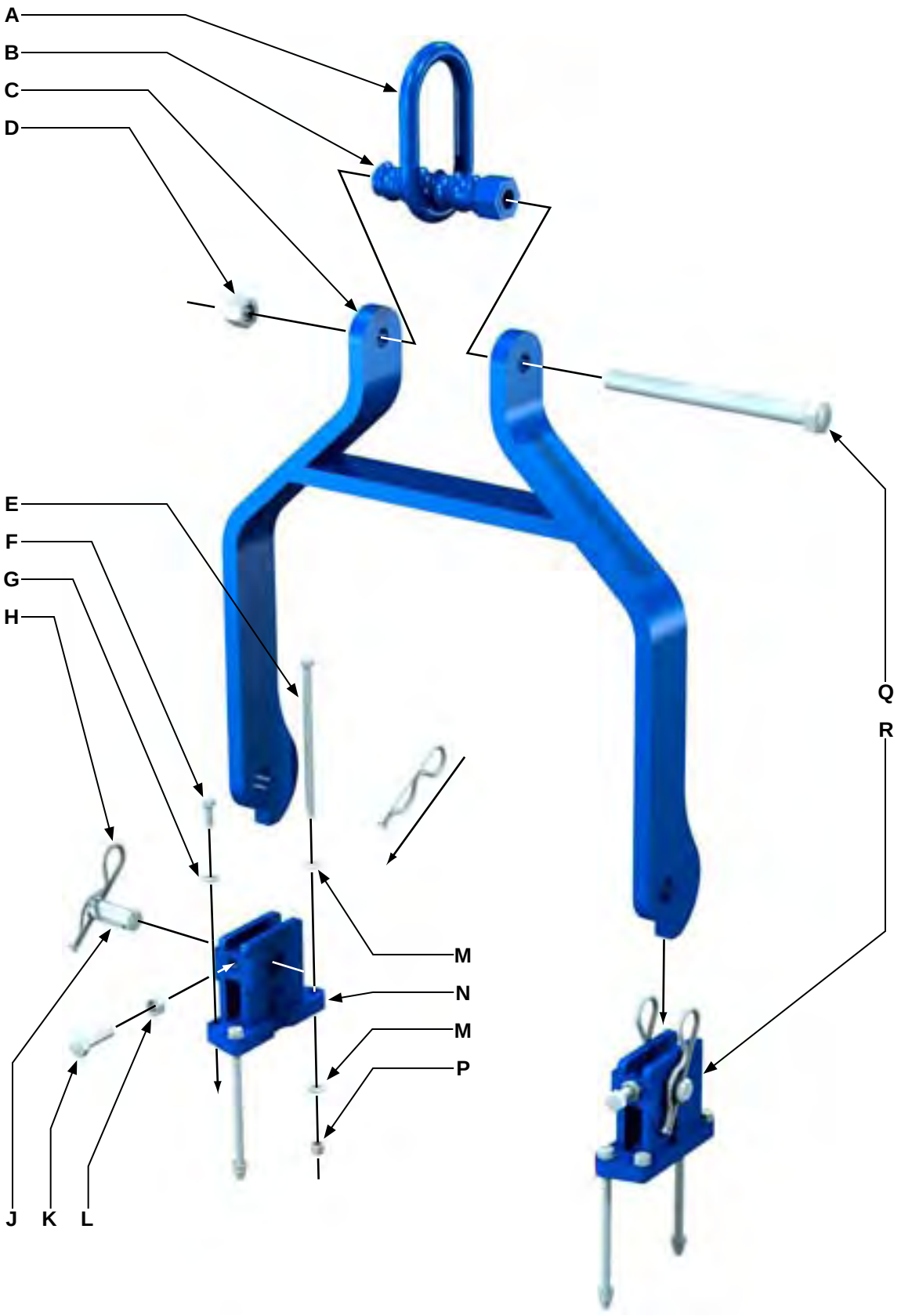


Item	Type	Description	Qty	Part Number
A	Part	Door Pin	2	AK12-708
B	Part	1" Narrow Flat Washer	4	09-5120
C	Part	1/2" x 1/2" Hex Socket UNC Shoulder Bolt	4	02-0973
D	Part	3/8" UNC x 2" Hex Bolt	4	09-1054
E	Part	3/8" Lock Washer	8	09-5106
F	Weldment	RH Door Stop Cylinder Mounting Lug	1	AK12-030_RH
G	Weldment	RH Door Weldment	1	AK12-700
H	Part	Thrust Bearing	4	AK12-001
J	Part	Sleeve Bearing	4	02-0495
K	Part	3/4" UNF Thin Nylock Nut	2	09-5718
L	Part	3/8" UNC x 1-1/4" Hex Bolt	4	09-1048
M	Part	Door Cylinder Bracket	2	AK12-706
N	Part	3/8" UNC x 1" Hex Socket Head Cap Screw	2	09-1738
P	Weldment	LH Door Stop Cylinder Mounting Lug	1	AK12-030
Q	Assembly	Door Stop Cylinder	2	101-0069
R	Weldment	LH Door Weldment	1	AK12-750
S	Weldment	Door Latch Bar Weldment	1	AK12-756
T	Part	Sleeve Bearing	2	02-0238
U	Part	1/2" x 5/8" Hex Socket UNC Shoulder Bolt	2	09-1342
V	Part	Door Latch Spring	1	AK12-757
W	Part	Safety Door Latch	1	AE13-302
X	Part	Door Latch Trigger	1	AK12-755
Y	Part	Safety Door Spring	1	02-E0099
Z	Part	7/16" UNF Hex Jam Nut	1	09-5508
AA	Part	Safety Door Cable, 48"	1	02-E0171
BB	Part	Safety Door Cable Guide Holder	1	101-5483
CC	Part	Safety Door Plunger	1	101-4360
DD	Part	Safety Door Valve Mounting Block	1	AE13-301
EE	Part	15/16" Valve Lock Nut	1	09-0278
FF	Part	5/16" NC x 3/4" Hex SHCS	4	09-2024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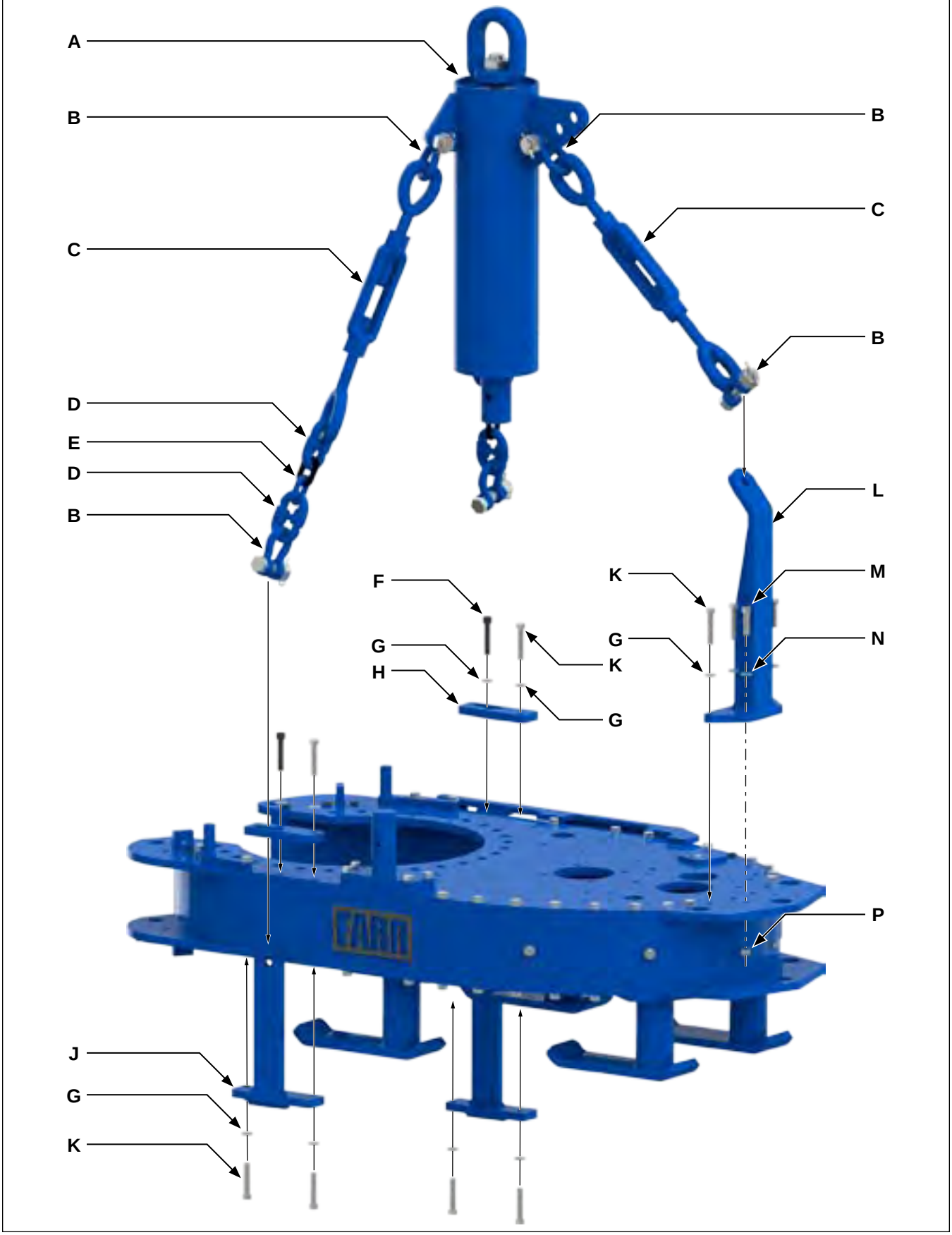
Item	Type	Description	Qty	Part Number
A	Part	Lifting Link	1	02-0516
B	Part	Rigid Sling Adjustment Helix	1	1053-1-H
C	Weldment	Rigid Sling Weldment	1	AK06-000B
D	Part	3/4" NC Nylock Nut	1	1429-39-02
E	Part	3/8" NC x 7" Hex Bolt	4	
F	Part	3/8" NC x 1" Hex Bolt	4	09-1046
G	Part	3/8" Helical Lock Washer	4	09-5106
H	Part	3/16" Hitch Pin	2	02-0028
J	Part	Rigid Sling Pin	2	AK00-056
K	Part	1/2" NC x 1-3/4" Hex Bolt	2	09-1172
L	Part	1/2" NC Hex Jam Nut	2	09-5810
M	Part	3/8" Narrow Flat Washer	8	09-5124
N	Weldment	RH Rigid Sling Bracket	1	101-1244
P	Part	3/8" NC Nylock Nut	4	09-5607
Q	Part	3/4" NC x 9" Hex Bolt	1	09-1322
R	Weldment	RH Rigid Sling Bracket	1	101-1245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Item	Type	Description	Qty	Part Number
A	Assembly	Spring Hanger	1	85-0106SX
B	Assembly	Shackle	6	02-9063
C	Assembly	Turnbuckle	3	02-6506
D	Part	Hammer Lock Link	4	02-0607
E	Part	2-Link Chain	2	101-1683
F	Part	3/8" UNC x 2" Hex Socket Head Cap Screw	2	09-2054
G	Part	3/8" Helical Lock Washer	12	09-5106
H	Part	Top Hanger Plate	2	101-1499
J	Weldment	LH Front Hanger Weldment	1	101-1494
	Weldment	RH Front Hanger Weldment	1	101-1498
K	Part	3/8" UNC x 2" Hex Bolt	10	09-1054
L	Part	Rear Chain Sling Hanger	1	AK06-220B
M	Part	1/2" UNC x 1-1/2" Hex Bolt	2	09-1170
N	Part	1/2" Helical Lock Washer	2	09-5110
P	Part	1/2" UNC Nylock Nut	2	09-5610

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A. BASIC TORQUE MEASUREMENT

Basic torque measurements are performed using a simple hydraulic measurement system. A hydraulic load cell connects to a calibrated torque gauge through a reinforced flexible hydraulic hose. The torque gauge is factory-calibrated to display accurate torque measurements for a tong or tong and backup assembly with a particular arm length. The arm length is a measurement from the centre of the pipe or casing to the centre of the force being applied to the load cell.

Two load cell options are available. A tension load cell is typically used with a suspended stand-alone tong. This application requires that the load cell be attached to the rear of the tong as part of the restraint line that opposes the force generated when the tong makes up or breaks out a joint. A compression load cell is used in a tong and backup assembly, and is typically located on the rear of the backup between the backup and a stationary frame. The load cell must be located in the centre of the compression force vector generated between the backup and the frame.

Hydraulic force generated by a load cell is transmitted to the torque gauge via a reinforced flexible hydraulic line. The hydraulic force is displayed as torque in units of Ft.-Lbs. The torque gauge has a red "peak torque" indicator that tracks with the torque gauge needle to the point of highest torque, and remains at the point of highest torque until manually reset. Note that every model of tong and tong and backup assembly has a unique arm length, and the torque gauge must be calibrated for that arm length. Torque gauges that are not calibrated for the arm length of the tool in service will not display correct torque. To ensure correct torque measurement, ensure the arm length or "handle" as displayed on your torque gauge matches the arm length of the tool in service as listed on the specifications page of the technical manual.

The images on this page are for illustration purposes only and may not accurately represent the torque gauge and load cell that have been supplied with your equipment.

THE IMAGES DISPLAYED ARE SUPPLIED FOR ILLUSTRATION PURPOSES ONLY

ILLUSTRATION 6.A.1: TORQUE GAUGE (FOR ILLUSTRATION PURPOSES ONLY)

ILLUSTRATION 6.A.2: TENSION LOAD CELL

ILLUSTRATION 6.A.3: COMPRESSION LOAD CELL

Torque gauges and load cells are supplied as a matched calibrated pair. Substituting one or the other will render the calibration inaccurate even if the actual model numbers appear to be identical. The serial numbers of matching load cell and torque gauges are clearly identified on the calibration certificate. Should you suspect the accuracy of your torque measurements, or wish to replace either component the pair should be returned to the factory for re-calibration before placing into service.

TORQUE GAUGES AND LOAD CELLS ARE FACTORY-SUPPLIED SUPPLIED AS MATCHED CALIBRATED PAIRS. IF REPLACING EITHER COMPONENT THE LOAD CELL AND TORQUE GAUGE MUST BE RETURNED TO THE FACTORY FOR RE-CALIBRATION BEFORE PLACED INTO SERVICE.

BASIC TORQUE MEASUREMENT (Continued:)

The images on the preceding page are for illustration purposes only and may not accurately represent the torque gauge and load cell that have been supplied with your equipment. Please note that the parts listed in the following table are correct for accurate torque measurement while using the equipment for which this manual is supplied.

THE TORQUE GAUGE USED IS FULLY DEPENDANT UPON THE ARM LENGTH AND TORQUE RANGE OF THE EQUIPMENT IN USE. THE PART NUMBERS LISTED IN THE FOLLOWING TABLE ARE CORRECT FOR ACCURATELY MEASURING TORQUE USING THE EQUIPMENT FOR WHICH THIS MANUAL IS SUPPLIED.

Item	Type	Description	Qty	Part Number
	Assembly	31" Arm - 15K Torque Gauge / Tension Load Cell Assembly	1	10-0070T
1	Part	31" Arm 20,000 Lbs.-Ft Torque Gauge	1	10-0070G
2	Part	4.08" Tension Load Cell	1	10-0008T
3	Part	Hydraulic Hose	1	02-0069
4	Part	Torque Gauge Flange	1	997-D7-5
5	Part	Tension Load Cell Shackle	1	02-0078

LOAD CELLS ARE NOT USER SERVICEABLE. ILLUSTRATION 6.A.4 IS PROVIDED FOR INFORMATION PURPOSES ONLY. DAMAGED LOAD CELLS MUST BE RETURNED TO THE FACTORY FOR REPAIR AND RE-CALIBRATION.

Item	Type	Description
	Assembly	Tension Load Cell, 4.08 in^2
A	Part	1/4" NC x 1/2" Binding Head Machine Screw
B	Part	Stat-O-Seal
C	Part	O-Ring
D	Part	O-Ring
E	Part	Load Cell Piston
F	Part	Flange Gasket
G	Part	Load Cell End
H	Part	Load Cell Rod
J	Part	Wiper
K	Part	O-Ring
L	Part	Load Cell Body
M	Part	3/8" NC x 3/8" Cup Point Hex Set Screw
Seal Kit		Replacement Seal Kit 4.08 in^2 Tension Load Cell

This is the standard tension load cell supplied by McCoy Drilling & Completions | Farr. Contact our sales department for information about optional application-specific tension load cells.

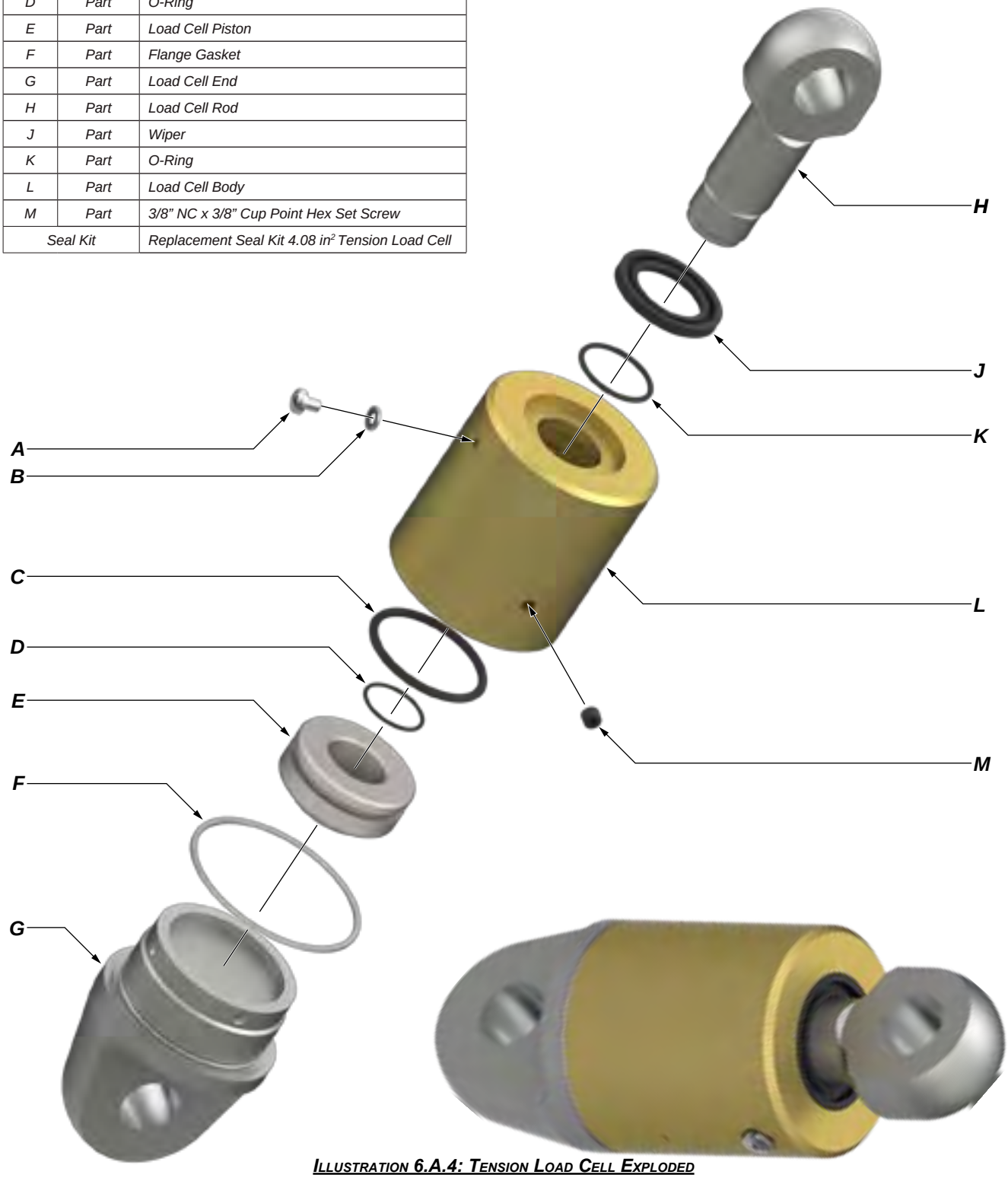
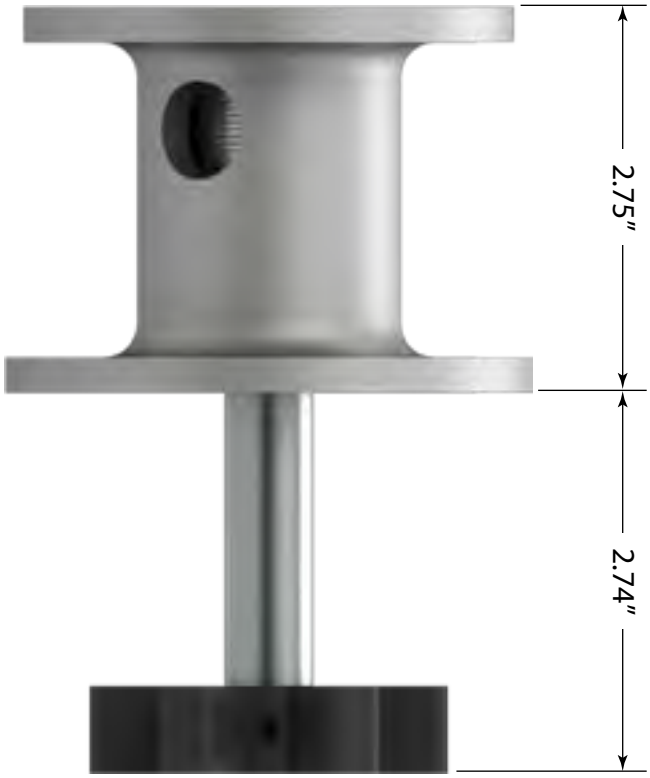
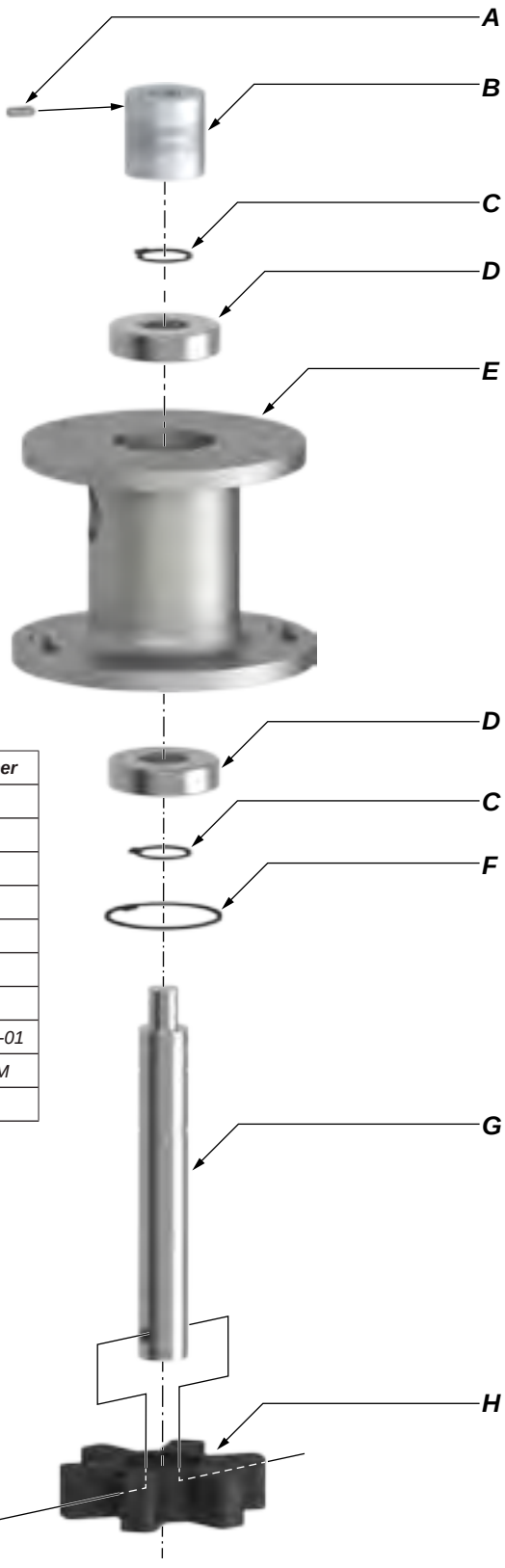


ILLUSTRATION 6.A.4: TENSION LOAD CELL EXPLODED





Item	Type	Description	Qty	Part Number
	Assembly	Standard Turn Counter Encoder Mount	1	60-0001
A	Part	6-32 x 3/8" Hex Socket Head Set Screw	4	
B	Part	Helical Flexible Encoder Shaft Coupling	1	60-0130N
C	Part	Internal Retainer Ring	2	1376-13
D	Part	Bearing	2	1376-05
E	Part	Encoder Housing	1	1392-104A
F	Part	Internal Retainer Ring	1	02-0436
G	Part	Encoder Shaft	1	1392-103A-01
H	Part	Encoder Gear	1	01-0320A-M
J	Part	10-24 x 1-1/4" Hex Socket Head Set Screw	1	

Illustration 6.A.5: Turn Counter Encoder Mount Exploded

B. TROUBLESHOOTING

Under normal operating conditions, and with proper maintenance, the torque gauge and load cell system are designed to give lasting trouble-free performance. Faulty indication on the gauge will very often define a fault within the gauge.

IF TROUBLESHOOTING REVEALS THAT THERE IS INSUFFICIENT FLUID IN THE SYSTEM, BEFORE RECHARGING, CHECK THAT ALL SYSTEM COMPONENTS ARE FREE FROM DAMAGE. THIS WILL ENSURE THAT FLUID LOSS WILL NOT CONTINUE AFTER RELOADING

1. ***Symptom:*** ***No indication on gauge.***

Possible Problem: *Obstruction in hydraulic hose.*

Solutions: *Check hydraulic hose for kinks.*
Replace hydraulic hose.

Possible Problem: *Loss of hydraulic fluid.*

Solution: *Recharge hydraulic fluid (see Section 6.C). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss.*

Possible Problem: *Internal mechanism of torque gauge is damaged.*

Solution: *Replace gauge.*

2. ***Symptom:*** ***Gauge indication unexpectedly high.***

Possible Problem: *Excessive hydraulic fluid.*

Solutions: *Completely drain hydraulic fluid from torque gauge/load cell system. Recharge following the procedure in Section 6.C.*

Possible Problem: *Internal mechanism of gauge is damaged.*

Solution: *Replace gauge.*

Possible Problem: *Incorrect torque gauge in use (not part of the original torque gauge/load cell pair).*

Solution: *Replace gauge with gauge properly calibrated for the load cell in service.*

3. ***Symptom:*** ***Gauge indication unexpectedly low***

Possible Problem: *Insufficient hydraulic fluid.*

Solution: *Recharge hydraulic fluid (see Section 6.C). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss.*

Possible Problem: *Obstruction in hydraulic hose.*

Solutions: *Check hydraulic hose for kinks.*

Replace hydraulic hose.

Possible Problem: *Snub line not at right-angle to tong handle.*

Solution: *Check angle of snub line and correct if necessary.*

Possible Problem: *Internal mechanism of gauge is damaged.*

Solution: *Replace gauge.*

Possible Problem: *Incorrect torque gauge in use (not part of the original torque gauge/load cell pair).*

Solution: *Replace gauge with gauge properly calibrated for the load cell in service.*

4. ***Symptom:*** ***Gauge indication is erratic or sluggish***

Possible Problem: *Insufficient hydraulic fluid in torque measurement section.*

Solution: *Recharge hydraulic fluid (see Section 6.C). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss.*

Possible Problem: *Loss of damping fluid in torque gauge.*

Solution: *Top up or refill damping fluid (NOTE: Ensure leakage points in gauge are identified and repaired to prevent further loss of damping fluid).*

Possible Problem: *Air bubbles in hydraulic fluid in the torque measurement system.*

Solution: *Bleed air from load cell and torque gauge and top up fluid (if necessary) as per Section 6.C.*

Possible Problem: *Internal mechanism of gauge is damaged.*

Solution: *Replace gauge.*

C. PERIODIC INSPECTION AND MAINTENANCE

1. Inspection

The torque measurement system supplied with your equipment is designed and built to provide years of trouble-free service with minimum maintenance. Periodic inspections of the load cell, hydraulic lines and fittings are recommended in order to keep the system in top operating condition. A thorough inspection should be made at each rig-up.

2. Fluid Recharge

Recharge hydraulic system with W15/16 fluid through the check valve on the torque indicating gauge. Recharging must only be performed when there is no load on the load cell. Refer to the illustrations on pages 6.3 & 6.4 for guidance if required.

a. *Place the torque indicating gauge higher than the load cell. Remove the brass 1/4" cap from the fitting on the check valve on the top of the gauge.*

b. *Connect the hand pump to the check valve fitting.*

c. *Elevate the load cell so it is higher than the torque gauge and hand pump.*

UN-CONTAINED SPILLAGE OF THE HYDRAULIC FLUID IN THIS SYSTEM MAY CONTRAVENE GOVERNMENTAL ENVIRONMENTAL REGULATIONS, OR THE ENVIRONMENTAL REGULATIONS AND POLICIES OF YOUR COMPANY. FARR CANADA CORP. HIGHLY RECOMMENDS PLACING YOUR LOAD CELL IN A CONTAINMENT BASIN BEFORE PROCEEDING WITH THE BLEEDING & REFILLING PROCESS.

d. *Fill hand pump bowl with W15/16 hydraulic fluid.*

MAINTAIN GREATER-THAN HALF FULL FLUID LEVEL IN THE HAND PUMP BOWL TO AVOID PUMPING AIR INTO THE SYSTEM. DO NOT ALLOW THE LEVEL TO FALL BELOW ONE-HALF FULL

e. *Remove the vent plug screw and Stat-O-Seal (Items C and D on Illustration 6.A.4, or item H on Illustration 6.A.5) to allow trapped air to escape.*

f. *Pump fluid into the system until no more air is seen escaping from the vent port.*

g. *Replace the vent plug screw and Stat-O-Seal and tighten securely.*

h. *Remove load cell from containment vessel and wipe clean. Reclaim the hydraulic fluid (if it is clean) or dispose of all waste materials according to governmental or your company's proscribed environmental protection regulations.*

i. *Disconnect the hand pump from the torque gauge.*

j. *Replace the brass cap on the torque gauge check valve fitting.*

3. Repair And Calibration

Load cell and indicator gauge should be returned to authorized repair facility for any repairs or calibration required.

MCCOY
MOVING GLOBAL ENERGY FORWARD

DRILLING & COMPLETIONS

FARR

Section 7: Hydraulic Component Information

The manufacturer information contained in this section has been obtained from publicly available web sites and has been provided for information purposes only. Farr Canada Corp. does not guarantee the accuracy of the information contained in this section. All original copyrights claimed by the manufacturer(s) apply.

MANUFACTURER OF HYDRAULIC MOTORS
RINEER® HYDRAULICS, INC.

15 series

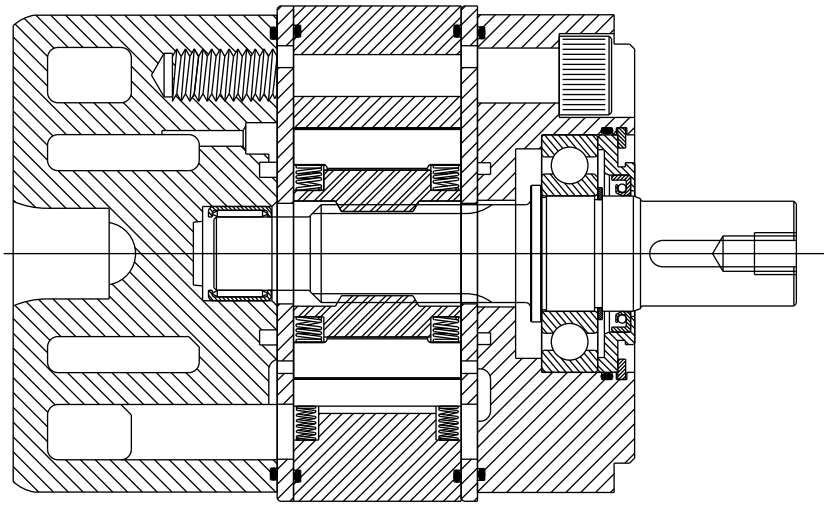
POWER to be the Best!

MOTOR SELECTION GUIDE

Features of the 15 Series Standard Motor: Standard Motor - 3000 PSI (Code 61)

- Eight fixed displacement motors ranging from 6 in^3 to 15 in^3.
- Starting and stall torques equal to 90-94% of theoretical torque.
- Speed to 2,000 RPM continuous.
- Up to 75 HP continuous.
- Conforms to SAE 'C' mounting specification.
- Weighs 43 lbs.

CROSS SECTION



Made in USA

PUBLICATION DS151005 8/03

Technical Information - All Styles

VANE CROSSING VANE
The Rineer patented vane crossing vane design produces much higher volumetric and mechanical efficiencies than is possible with a standard vane type design. This design provides a sealing vane between cavities to improve mechanical and volumetric efficiencies.

STARTING AND STALL TORQUE
The Rineer motor produces torque curves which are virtually flat, with starting and stall torque equal to approximately 90-94% of theoretical torque.

MORE POWER STROKES PER REVOLUTION
The 15 Series has four stator cavities and 10 rotor vanes. Each rotor vane works in each stator cavity once per revolution, which results in 40 power strokes per revolution. This helps produce higher mechanical efficiency and flatter torque curves.

BEARING LOADING
The bearings in the 15 Series can accept radial load per the radial capacity chart. Thrust load is not recommended under most conditions. Consult with a Rineer Application Engineer for optional bearing configurations to match your application.

SEALS
Buna N seals are supplied as standard on the Rineer 15 series motors. Viton seals may be ordered as an option.

ROTATING GROUP - 1S or 1H
Under most operating conditions, 1S (standard rotating group parts) should be used. Under some high speed conditons 1H can be specified.

ROTATION
The 15 Series Motor rotates equally well in either direction and smoothly throughout its entire pressure and speed range. Looking into the end of the shaft, rotation is clockwise when oil is supplied to port "A".

HORSEPOWER LIMITATION
Maximum horsepower limitations may vary with different applications. ***When using the 15 Series Motor above 75 HP, consult a Rineer Application Engineer.***

FILTRATION
25 micron minimum.

FLUID
We suggest premium grade fluids containing high quality rust, oxidation and foam inhibitors, along with anti-wear additives. For best performance, minimum viscosity should be maintained at 100 SSU or higher. Fluid temperature should not exceed 180° F. Elevated fluid temperature will adversely affect seal life while accelerating oxidation and fluid breakdown. Fire resistant fluids may be used with certain limitations. Contact Rineer for additional information.

CASE DRAIN
The 15 Series Motor is designed for either internal or external case drain. Two case drain ports are supplied. When using internal case drain, simply plug the two ports. When using external case drain, use the port at the highest elevation. We recommend case drain pressure of 35 PSI or less when using the standard seals.

CASE DRAIN CIRCULATION
Fluid should be circulated through the case when a temperature differential exists between the motor and the system in excess of 50° F. ***Should this occur, contact a Rineer Application Engineer.***

MOUNTING
The mounting position is unrestricted. The shafts, pilots, and mounting faces should be within .002 TIR.

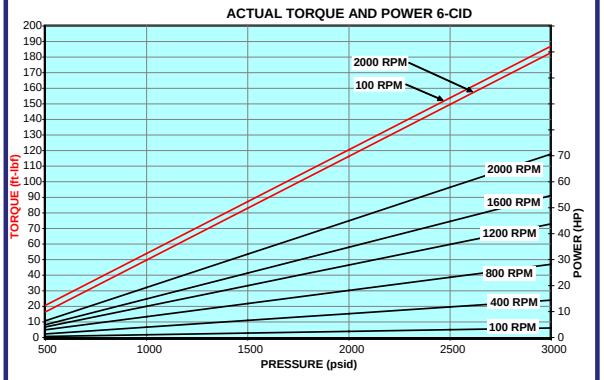
INTERMITTENT CONDITIONS
Intermittent conditions are to be less than 10% of every minute.

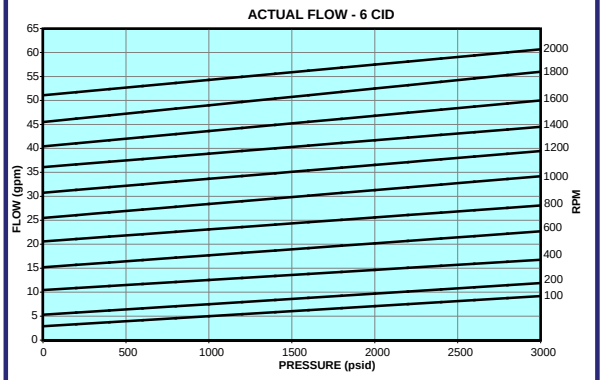
OTHER AVAILABLE MOTORS
For information on additional Rineer Motors, request one of the following publications:

37 Series .....Publication DS371003
57 Series .....Publication DS571003
125 Series .....Publication DS1251003

Performance Data - Selected Displacements

6 C.I.D.





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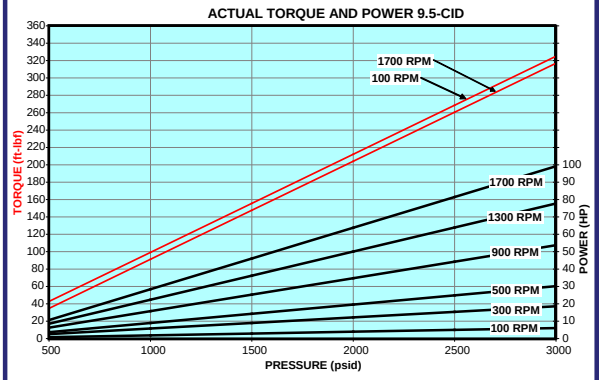

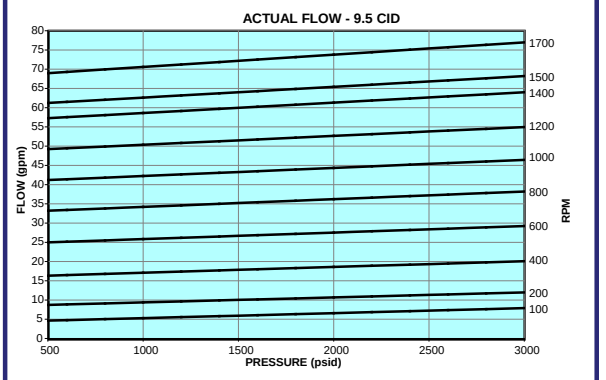

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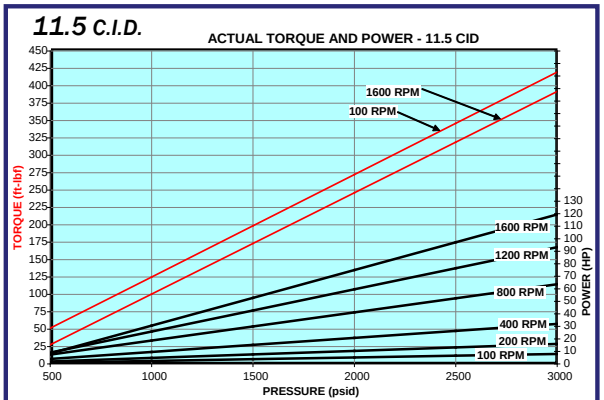
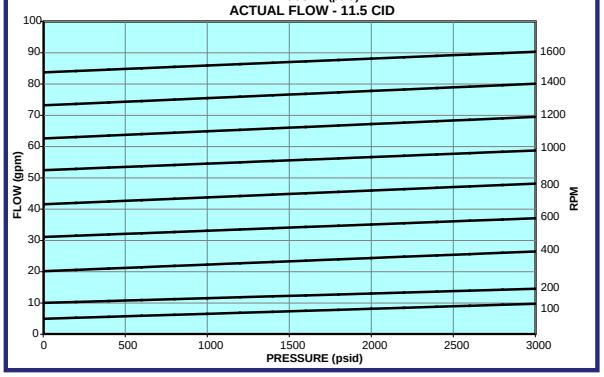
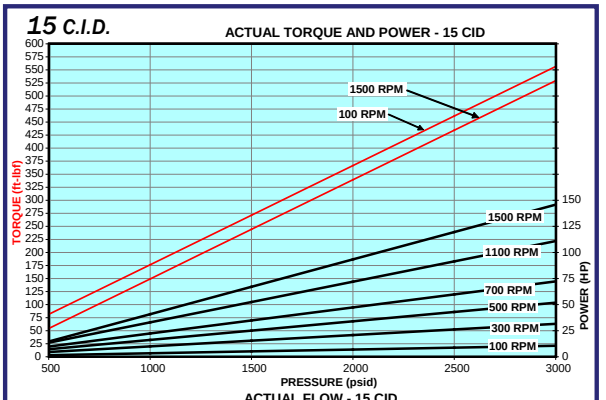
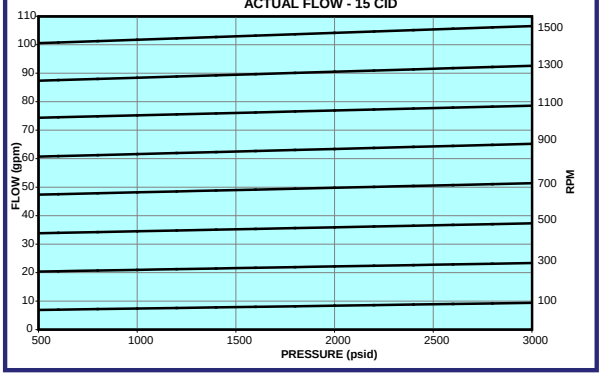




15 C.I.D.





The above performance data was obtained at 140°F with ISO 46(DTE 25). These values must be maintained to obtain the performance indicated. Contact Rineer Hydraulics, Inc. for additional displacements.

Model Code

M015 - 61/62

- M015 - 61 = 015 Single Speed
- M015 - 62 = 015 Two Speed

Options:
- 62 = Two Speed Single Pilot Open During Crossover
- 63 = Two Speed Single Pilot Closed During Crossover
- 65 = Two Speed Double Pilot Open During Crossover
- 67 = Two Speed Double Pilot Closed During Crossover

-1S

- 1S = Std.
- 1H = High Speed

-015

- 006 = 6 in³ (98cc)/rev.
- 007 = 7 in³ (115cc)/rev.
- 008 = 8 in³ (131cc)/rev.
- 009 = 9.5 in³ (156cc)/rev.
- 010 = 10.5 in³ (172cc)/rev.
- 011 = 11.5 in³ (189cc)/rev.
- 013 = 13 in³ (213cc)/rev.
- 015 = 15 in³ (246cc)/rev.

-31

- 30 = Keyed Shaft
- 31 = Splined Shaft
- 32 = Wheel Motor
- 34 = Double Key
- 50 = Retractable
- 53 = API Thread

-B1 — Bearing Package Selection

-TV — Seal - Package Selection

-000 — Special Code Designator

Applications

For durable hydraulic motors that meet your demands, specify Rineer.

For over 35 years, we have specialized in only one thing - engineering the right motor for your needs. Rineer delivers the performance you can count on·

Limited Warranty Policy

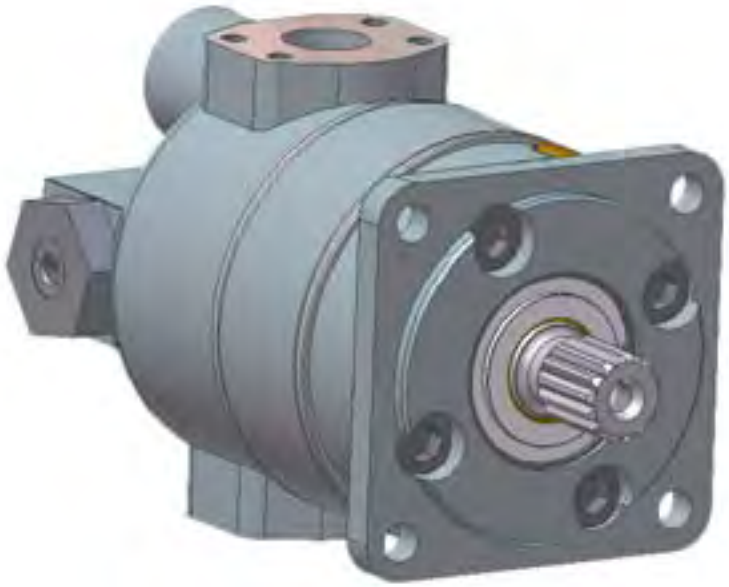
Rineer Hydraulics, Inc. warrants that, at the time of shipment to Purchaser, our product will be free of defects in the material and workmanship. The above warranty is LIMITED to defective products returned by Purchaser to Rineer Hydraulics, Inc., freight prepaid within four hundred and fifty-five (455) days from date of shipment, or one (1) year from date of first use, whichever expires first. We will repair or replace any product or part thereof which is proved to be defective in workmanship or material. There is no other warranty, expressed or implied, and in no event shall Rineer Hydraulics, Inc. be liable for consequential or special damages. Dismantling the product, operation of the product beyond the published capabilities or for purposes other than that for which the product was designed, shall void this warranty.

331 Breesport San Antonio, Texas 78216
210-341-6333 Fax: 210-341-1231 e-mail: sales@rineer.com

Repair Manual

15 Series

Standard Motor



Two Speed Motor

331 BREESPORT * SAN ANTONIO, TX 78216 * (210) 341-6333 FAX (210) 341-1231

SERIES 15 STD. MOTOR EXP. VIEW

ITEM	PART NO.	DESCRIPTION	QTY
1	0150111	SEAL PLATE SNAP RING	1
2	0150135	SEAL PLATE	1
3	0150161	SEAL, SHAFT, TCN	1
4		NOT USED	
5	0150114	SEAL PLATE O-RING	1
6	0150730	SNAP RING, BEARING	1
7	0150710	BALL BEARING	1
8	0150701	SHAFT, KEYED	1
	0150702	SHAFT, SPLINED	1
9	0150901	BOLT	4
10	0150102	FRONT HOUSING-INTERNAL	1
11	0150428	DOWEL PINS - FRONT	2
12	0150610	O-RING	4
13	0150902	BALL CHECKS	4
14	0150620	PLATE SCREW	4
15	0150608	PLATE	2
16	0150400	STATOR GA 11.5	1
	0150401	STATOR GA 15	1
	0150402	STATOR GA 13	1
	0150403	STATOR GA 9.5	1
	0150404	STATOR GA 8.0	1
	0150406	STATOR GA 7.0	1
	0150407	STATOR GA 6	1
	0150409	STATOR GA 3.0	1
17	0150300	ROTOR	1
18	0150313	ROTOR VANE	10
19	0150320	ROTOR VANE SPRING OUTER	20
20	0150321	ROTOR VANE SPRING INNER	20
21	0150410	STATOR VANE	4
22	0150420	STATOR VANE SPRING	8
23	0150429	DOWEL PINS - REAR	2
24	0150720	NEEDLE BEARING	1
25	0150800	REAR HOUSING	1

SERIES: 15
EXPLODED VIEW
MODEL CODE: 015-61-15-015-30-B1-TB-XXX
STANDARD MOTOR
RINEER HYDRAULICS
CORPUS CHRISTI, TEXAS
RECORD REFERENCE
DRAWN BY: JERRY W
DATE: 4-14-98
DWG. NO. 0150041

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

REMOVAL OF SHAFT SEAL

1

1) Remove snap ring

WARNING: Use caution when removing snap ring. If released accidentally it can become an airborne hazard.

2

1) Pry out shaft seal plate with two screw drivers.
2) Remove seal plate o-ring from groove in bearing bore.

REMOVAL OF WHEEL MOTOR SEAL PLATE AND BEARING BOX

3

1) Loosen and remove 8 each 10-32 bolts.
2) Pry off seal plate with screw driver.

4

Loosen and remove 8 each 3/8" bolts with 5/16" socket head wrench.

5

1) Two of the 3/8" bolt holes are provided with jack screw threads.
2) Insert a piece of 1/4" round stock by 2-1/2" long into each jack screw hole
3) Screw two 7/16-14 bolts into the jack screw threads until the bearing box is free of the motor.

6

Lift up on the bearing box to remove from motor.

DISASSEMBLY OF WHEEL MOTOR BEARING BOX

7

1) Loosen clamp screw in lock nut.
2) Unscrew lock nut and remove.

8

1) Press shaft out of bearing box.
2) Proceed to step 9, disregarding steps 11 & 12

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

DISASSEMBLY OF FRONT HOUSING AND SHAFT

9

1) Mark one side of the motor for proper assembly, paying careful attention that the cartridge will not be installed upside down.
2) Secure the motor prior to loosening the 5/8-11 bolts.

10

1) Remove front housing
2) Note: Two 5/16" ball checks and one main body o-ring may be dislodged and fall free.

11

With the seal plate removed, press shaft and ball bearing out of front housing.

12

1) Remove snap ring from shaft.
2) Press shaft out of bearing.

DISASSEMBLY OF ROTOR/STATOR CARTRIDGE

13

Lift up rotor/stator cartridge and remove from the rear housing.

14

1) Place cartridge on any object which will hold it off the table.
2) Remove two each 10-32 place screws.
3) Remove timing plate.

15

1) Remove o-ring and springs with a small screwdriver.
2) Remove dowels pins.

16

1) Replace plate on rotor/stator cartridge.
2) Turn rotor/stator cartridge over.
3) Repeat steps 14 & 15.

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

17

1) Remove the rotor.
2) Remove both the rotor and stator vanes.
3) Note: On motors manufactured prior to 1987, rotor vane slots and rotor vanes should be numbered so that vanes can be reassembled in the same vane slot.

INSPECTION AND REPLACEMENT OF PARTS

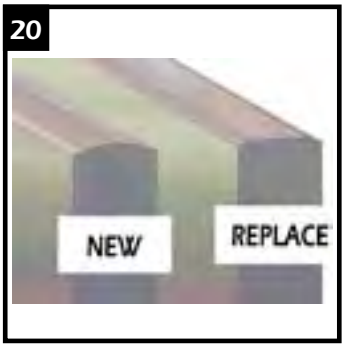
18

Inspect all springs and seals. We recommend replacement of all seals and springs whenever the motor has been disassembled.

19

Inspect all parts and replace any parts which obviously show excessive wear or damage.

20



VANES: Normal wear results in slight flattening of vane tips which does not impair motor performance. Replace vane if radius is reduced by 50%. Clearance between the rotor vane and rotor vane slot varies with the vane selection. The design allows the vane to "lean" slightly in the slot, providing the required mechanical seal.

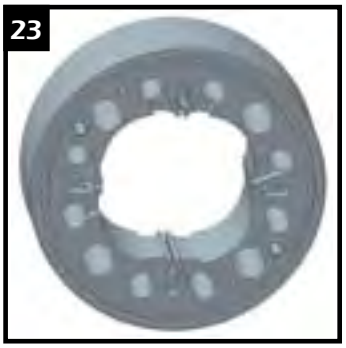
21

PLATES: Normal wear results in marking of timing plates which does not impair motor performance. Replacement of the timing plate is required if any smearing, galling, or heat cracks are present.

22

ROTOR: Normal wear results in polishing of rotor faces which does not impair motor performance. Examine the rotor vane slots closely. Polishing down in the slots is normal, but if there is any indication of a "pocket" forming in the wall of the slot, the rotor should be replaced.

23



STATOR: Normal wear results in polishing of cam form which does not impair motor performances. Noticeable wear may be apparent along the corner of one side of the staor vane slot. This does not necessarily require replacement of the stator, but may slightly affect volumetric efficiency.

24

Note: Measure the rotor and stator length to the fourth decimal point and supply measurement when ordering rotor, stator, or vanes.

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

ASSEMBLY OF ROTOR/STATOR CARTRIDGE

25

1) Reverse the procedures in steps 17, 16, 15, and 14
2) NOTE: Make sure that the radiused edge of each stator vane points to the rotor and the radiused edge of each rotor vane points to the stator.
3) NOTE: Make sure springs are seated in the bottom of the spring pocket in both the rotor and stator.

ASSEMBLY OF FRONT HOUSING

26

1) Press bearing onto shaft.
2) Install snap ring.

27

Press shaft and bearing assembly into front housing by pressing on the outer race of bearing.

28

1) Place seal in seal plate.
2) Place seal plate o-ring into groove in the front housing.
3) Press seal plate into front housing.
4) Install snap ring.
5) Proceed to step 30.

ASSEMBLY OF WHEEL MOTOR FRONT HOUSING

29

1) Reverse the procedures in steps 8 thru 3.
2) Screw lock nut onto shaft until all threads are engaged.
3) Tighten clamp screw until lock nut turns with a slight drag.
4) Tighten lock nut until desired rolling drag of bearing is obtained - see procedure Page 9.
5) Tighten clamp screw
6) Tighten all seal plate bolts.

ASSEMBLY OF MOTOR

30

1) Install dowel pins into rear housing.
2) Install ballchecks into rear housings.
3) Install main body o-ring.

31

1) Place rotor/stator cartridge onto rear housing.
2) NOTE: Make sure assembly marks from step 3 are lined up.

32

1) Install main body o-ring into front housing.
2) Install ball checks into front housing.
3) Place a small amount of grease over ball checks and o-ring.
4) Wipe off excess grease.

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

33

1) Install dowel pins into rotor/stator cartridge.
2) Pour a small amount of clean oil into the cartridge.
3) Install front housing onto rotor/stator cartridge.
4) Make sure alignment marks are lined up.

34

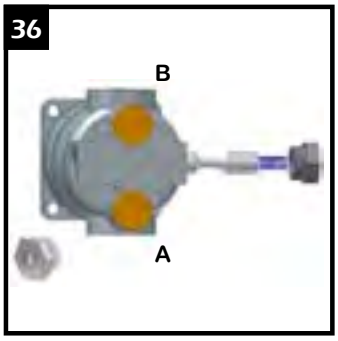
1) Install 5/8-11 bolts.
2) Torque bolts to 50 ft./lbs.

35

1) Rotate shaft in both directions to assure that the shaft turns smoothly.
2) Torque motor to 190 ft./lbs.
3) Rotate shaft again in both directions to assure that the shaft turns smoothly.

SPOOL ASSEMBLY FOR THE TWO SPEED MOTOR

36

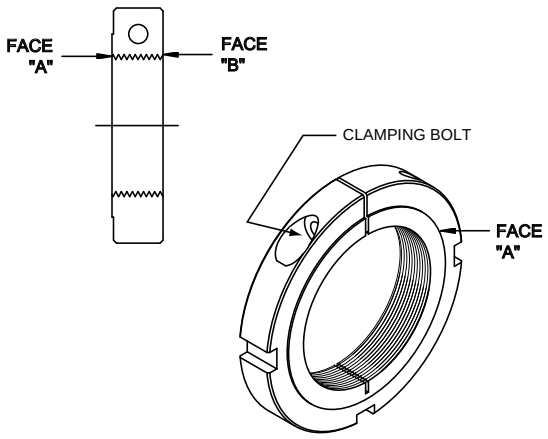


NOTE: Spool should be oriented as shown for two speed motors with model codes 62, 63, 68, & 69.

NOTE: Slight design variations may exist in motors manufactured either before or after the printing of this manual.

WHEEL MOTOR SHAFT AND BEARING ASSEMBLY PROCEDURE

1) Clean ALL assembly parts w/ lacquer thinner.
2) Dip clampnut and clamping bolt separately in lacquer thinner.
   (Steps 3 thru 10 must be conducted to completion ONE assembly at a time.)
3) Press bearing cups into bearing housing. Make sure they are pressed completely against bearing shoulders.
4) Coat inner race of large cone with #609 (green) Loctite and press cone onto the shaft. Make sure the cone is completely against the shoulder of the shaft.
5) Insert shaft and large cone into bearing housing.
6) Coat inner race of small cone with #609 (green) Loctite and press small cone onto shaft.
7) Apply #272 (red) Loctite to the clampnut threads of the shaft. Apply #242 (blue) Loctite to the threads of the clamping bolt and install in the clampnut.
8) Spin clampnut onto shaft with the "B" face towards bearings. After the nut threads are fully engaged, but prior to the nut contacting the bearings, tighten the clamping bolt until there is drag on the clamping nut (see note Fig. 1). Tighten the nut until a 20 to 30 inch pound rolling torque is achieved.
9) Tighten clamping bolt on clampnut to 70 inch pounds and recheck rolling torque. Apply inspectors lacquer to head of the bolt.
10) Allow a minimum of 24 hrs. to dry.



Note:
The slit in the clampnut allows for loose assembly on the shaft. Once in position, the clampnut clamping bolt MUST be tightened to a slight drag in order to correctly engage the threads on the shaft to achieve the clamp force required.

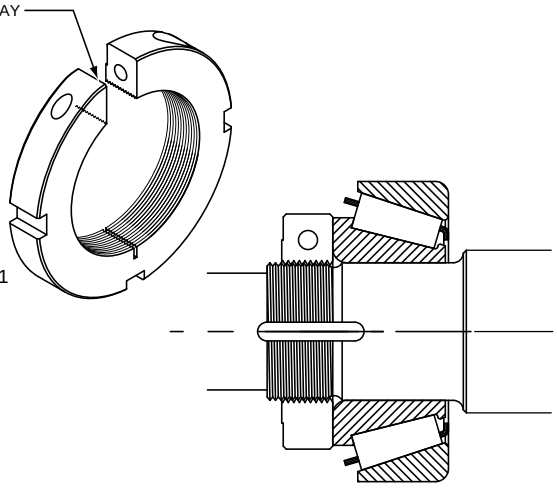
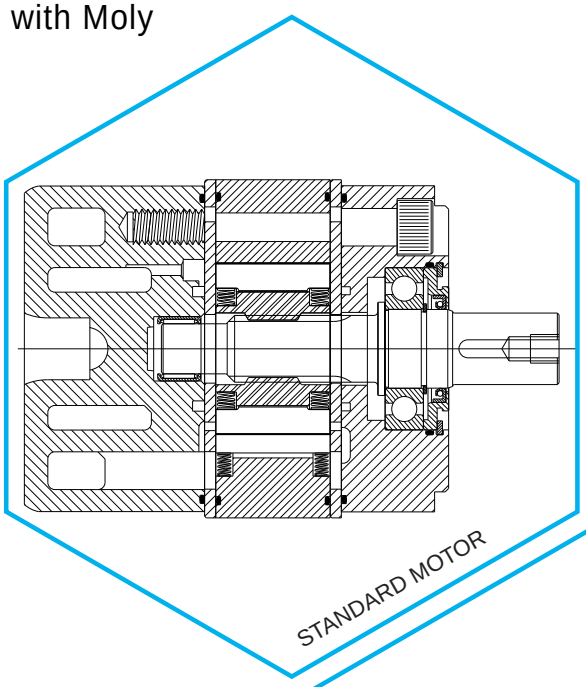


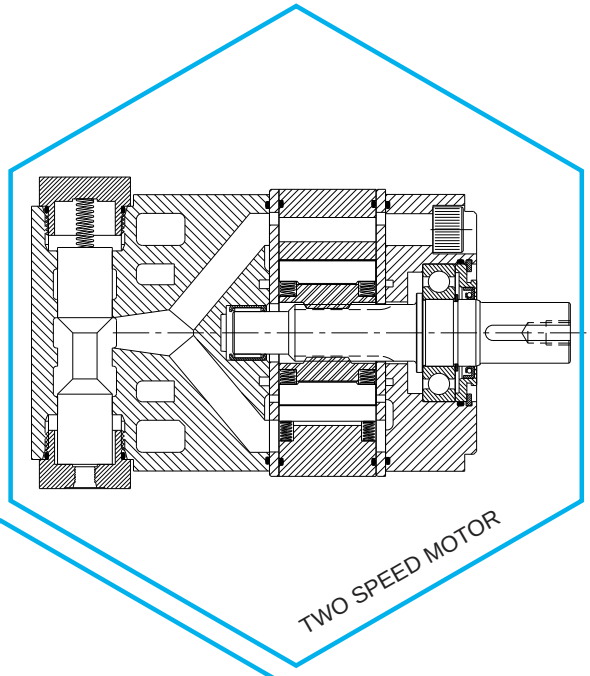
Figure 1

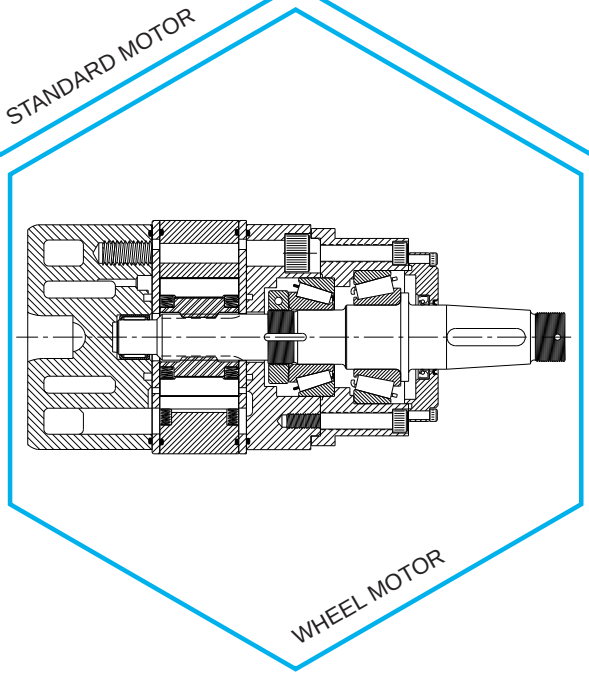
Information:

Bolt Torque -
Main Bolts (5/8-11): 190 ft. lbs.
Seal Plate (3/8-16)
(Wheel Motor only): 45 ft. lbs.
Grease used for bolt threads
and o-ring retention:
Pennzoil 707L RED
Shaft seal assembly lube:
Mobilgrease special
with Moly

Seal Kits:
Standard 15 series seal kit
#0150940
Standard 15 two speed seal kit
#0150940
Standard 15 wheel motor seal kit
#0150936







331 Breesport San Antonio, Texas 78216
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Vane motors
Single & double
M3B - M4 / M4S series

Publ. 2 - AM 157 - B 07 / 97 / FB Replaces : 2 - AM 157 - A

DENISON Hydraulics

TECHNICAL DATA - M3B AND M4* SERIES

Series	Size	Displ.	Theor. Displ. V_i	Torque T	Power at 100 Rev/min	Torque T	Power P
						n = 2000 RPM at Δ p 2500 PSI	
			$in^3/rev.$	in.lbf/PSI	HP/100 PSI	in.lbf	HP
M3	B B1	009	.56	0.08	0.014	174.3	5.8
		012	.75	0.11	0.018	236.3	7.8
		018	1.13	0.19	0.030	412.4	13.4
		027	1.70	0.30	0.046	680.5	21.8
		036	2.26	0.38	0.060	902.6	28.3
M4	C C1 SC SC1	024	1.49	0.24	0.037	535.4	17.0
		027	1.72	0.28	0.043	619.5	19.7
		031	2.11	0.33	0.054	768.0	24.1
		043	2.84	0.45	0.072	1062.0	33.6
		055	3.59	0.57	0.091	1318.6	41.8
		067	4.34	0.69	0.111	1504.5	47.7
		075	4.89	0.78	0.120	1752.2	55.6
	D D1 SD SD1	062	3.97	0.63	0.102	1460.0	46.4
		074	4.69	0.75	0.120	1770.0	56.2
		088	5.56	0.88	0.139	2088.5	66.2
		102	6.44	0.96	0.166	2336.3	74.1
		113	7.12	1.13	0.185	2655.0	84.2
		128	8.08	1.28	0.203	3009.0	95.5
		138	8.81	1.40	0.222	3292.0	104.5
	E E1 SE/SE1	153	9.67	1.54	0.240	3522.0	111.8
		185	11.69	1.86	0.296	4283.2	136.0
		214	13.55	2.16	0.342	5017.7	159.3
	DC DC1 SDC SDC1	See M4C/C1/SC/SC1 and M4D/D1/SD/SD1					

Internal drain : All these motors may be equiped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

For further information or if the performance characteristics outlined above do not meet your own particular requirements, please consult your local DENISON Hydraulics office.

GENERAL CHARACTERISTICS

	Mounting standard	Weight without connector and bracket - lbs	Moment of inertia $lb.in^2$	Option for inlet and outlet port	
M3B	SAE J744c ISO/3019-1 SAE A	17.6	1.03	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 3/4" BSPP threaded	
M4C/SC	SAE J744c ISO/3019-1 SAE B	34.0	2.7	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1"	
M4D/SD	SAE J744c ISO/3019-1 SAE C	59.5	1.4	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1"1/4	
M4E/SE	SAE J744c ISO/3019-1 SAE C	99.0	20.0	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 2"	
M4DC/SDC	SAE J744c ISO/3019-1 SAE C	88.0	10.0	SAE 4 bolt J718c ISO/DIS 6162-1 - 1"1/4	**P2 = See M4C/M4SC**

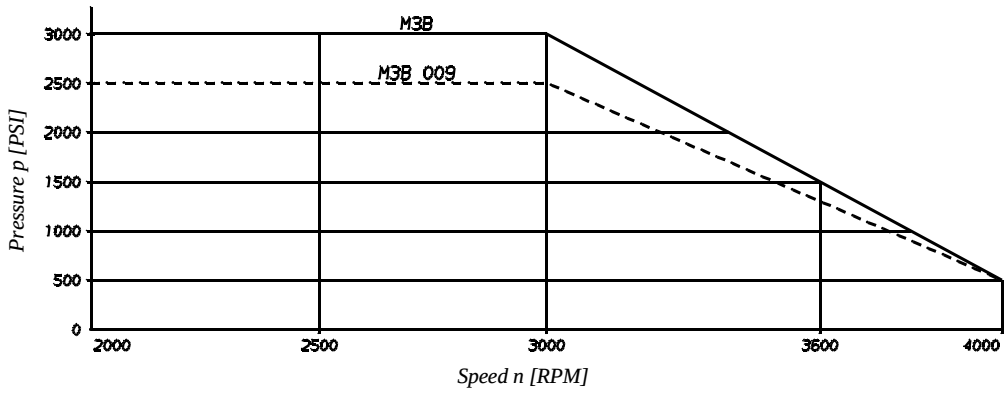
MAXIMUM SPEED, PRESSURE RATINGS - M3B AND M4* SERIES

Series	Size	Displ.	Max. pressure					Operating pressure range drain	Max. speed for low loaded condition [1]	Max. speed for max. pressure ratings					
			HF-0 HF-2	HF-2A	HF-1	HF-3 HF-5	HF-4			HF-0, HF-2		HF-2A		HF-1	
										Cont.	Int.[2]	Cont.	Int.[2]	Cont.	Int.[2]
			PSI	PSI	PSI	PSI	PSI	PSI	RPM	RPM	RPM	RPM	RPM	RPM	RPM
M3	B B1	009	2500					22	4000	3000	3600				
		012	3000												
		018													
		027													
		036													
M4	C C1	024	2500	2500	2500			50	4000	2500	3600	2500	3000	2000	2500
		027													
		031													
		043													
		055													
		067													
		075													
	SC SC1	024	3400	3000	2500	2500	2000								
		027													
		031													
		043													
		055	3000	3000											
		067													
		075	2500	2500											
	D D1	062	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500
		074													
		088													
		102													
		113													
		128													
		138													
	SD SD1	062	3400	2700	2000	2000	2000								
		074													
		088													
		102	3000	2700											
		113													
		128	2700	2700											
		138	2500	2500											
	E E1	153	2500	2500	2000				3600	2500	3000	2500	2800	1800	2200
		185													
		214													
	SE SE1	153	2700	2500	2000	2000	2000								
		185	2600												
		214	2500												
	DC DC1	All models	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500
	SDC SDC1	D-062 at 088	3400	2700	2000	2000	2000								
		C-024 at 043													
		D-102	3000	2700											
		D-113													
		C-055													
		C-067													
		D-128	2500	2500											
		D-138													
		C-075													

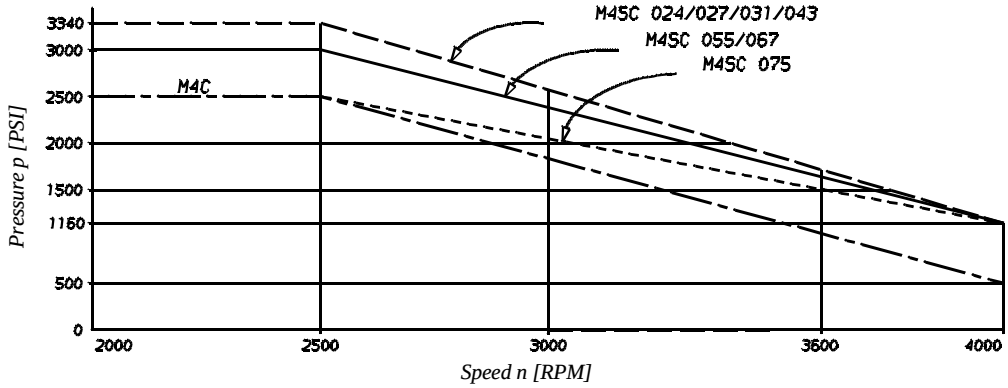
1) Low loaded condition 500 PSI for M3 and M4, 1160 PSI max. for M4S (see page 6).
2) Intermittent speed - Do not exceed 6 seconds per minute of operation.
HF-0, HF-2 = Antiwear petroleum base. HF-2A = Crankcase. HF-1 = Non antiwear petroleum base. HF-5 = Synthetic fluids.
HF-3 = Water in oil emulsions. HF-4 = Water glycols.
Internal drain : All these motors may be equiped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

MAX. SPEED AND MAX. CONTINUOUS PRESSURE - M3B AND M4* SERIES

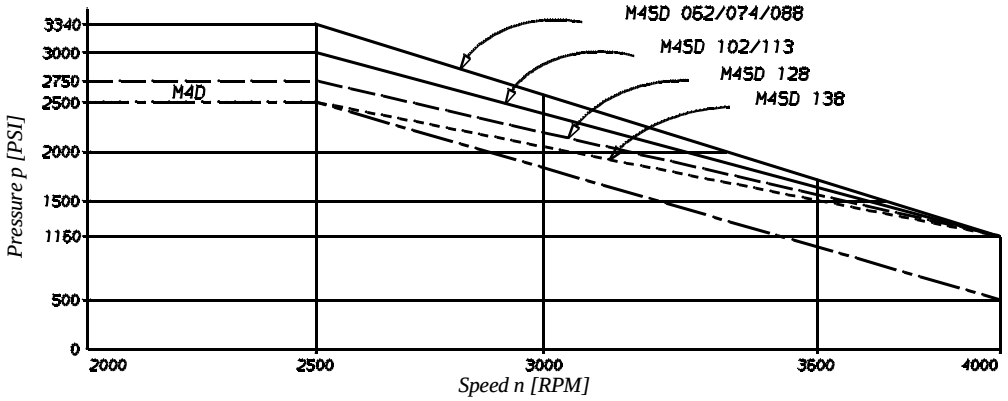
M3B



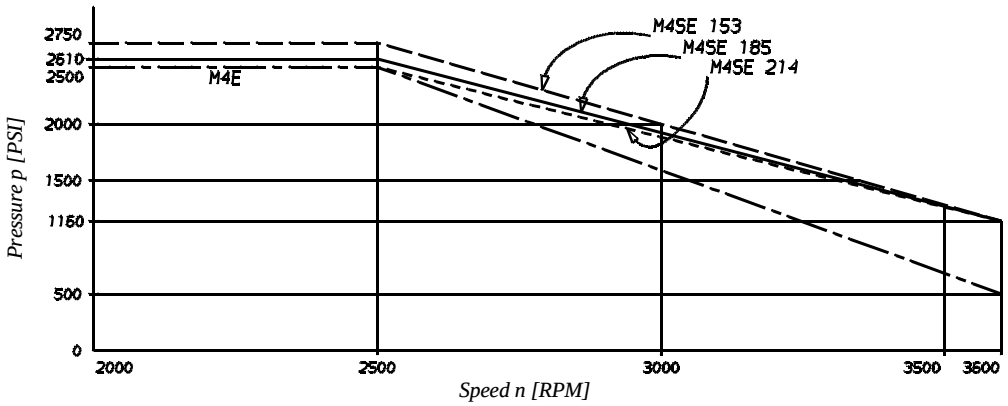
M4C/M4SC



M4D/M4SD



M4E/M4SE



MOTOR SELECTION - M3B AND M4* SERIES

Performances required

Torque	*T*	*[in.lbf]*	*1240*
Pump flow (available) at 115 SUS	q_{Ve}	*[GPM]*	*30.4*
Speed	*n*	*[RPM]*	*1500*
Pressure	*p*	*[PSI]*	*2500*

1. Check if available power is compatible with required power (0.85 estimated overall efficiency).

$$0.85 \times \frac{Q_{Ve} \times p}{1714} \geq \frac{T \times RPM}{63025}$$

$$0.85 \times \frac{30.4 \times 2500}{1714} \geq \frac{1240 \times 1500}{63025}$$

$37.7 > 29.5$

Two ways of calculation :

2a.Calculate V_i from T required torque

$$V_i = \frac{2 \pi \times T}{p} = \frac{2 \pi \times 1240}{2500} = 3.12 \ in^3/_{rev.}$$

3a. Motor choose from V_i immediately greater
M4C 055 V_i = 3.59 in^3/rev.

4a. Check real motor pressure for T = 1240 in.lbf around 1500 RPM
M4C 055 T = 1240 in.lbf n = 1500 RPM
p = 2370 PSI (see page 15)

5a. Flow loss M4C 055 at 2370 PSI at 115 SUS
q_{Vs} *= 4.2 GPM (see page 22)*
Real flow used by the motor :
$q_V = q_{Ve} - q_{Vs}$ *= 30.4 - 4.2 = 26.2 GPM*

6a. Real speed of the motor :

$$n = \frac{q_V \times 231}{V_i} = \frac{26.2 \times 231}{3.59} = 1686 \ RPM$$

Real performances

V_i	=	3.59 in^3/rev.	*M4C 055*
n	=	1680 RPM	
T	=	1240 in.lbf	
p	=	2370 PSI	

2b. Calculate V_i from q_{Ve} available flow

$$V_i = \frac{30.4 \times 231}{1500} = 4.68 \ in^3/_{rev.}$$

3b. Motor choose from V_i immediately smaller
M4C 067 V_i = 4.34 in^3/rev. (see page 22)

4b. Check motor press. with T = 1240 in.lbf at 1500 RPM
M4C 067 T = 1240 in.lbf n = 1500 RPM
p = 2030 PSI (see page 15)

5b. Flow loss of M4C 067 at 2030 PSI at 115 SUS
q_{Vs} *= 3.7 GPM (see page 22)*
Real flow used by the motor :
$q_V = q_{Ve} - q_{Vs}$ *= 30.4 - 3.7 = 26.7 GPM*

6b. Real speed of the motor :

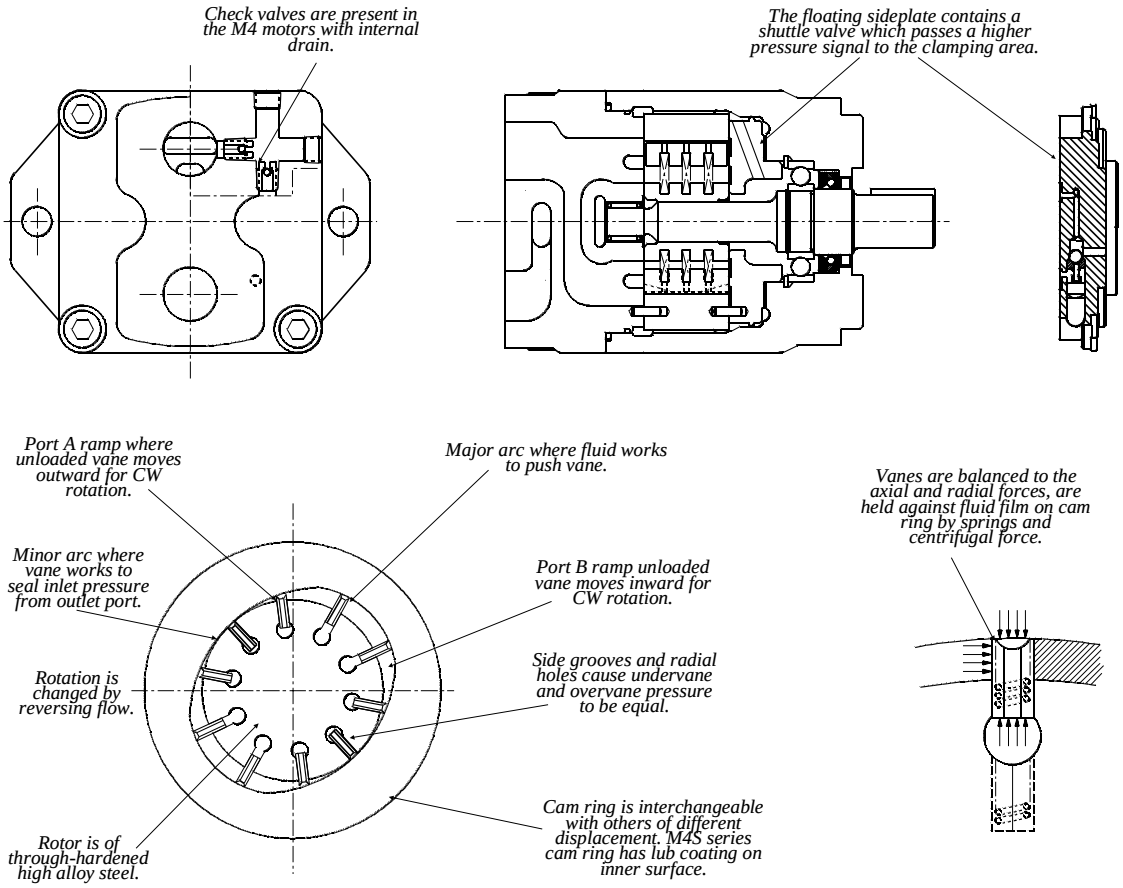
$$n = \frac{q_V \times 231}{V_i} = \frac{26.7 \times 231}{4.34} = 1420 \ RPM$$

Real performances

V_i	=	4.34 in^3/rev.	*M4C 067*
n	=	1420 RPM	
T	=	1240 in.lbf	
p	=	2030 PSI	

In each case always choose the smallest motor which will operate at the highest speed and pressure, and offers the most efficient solution.

DESCRIPTION - M3* AND M4* SERIES



OPERATION - SINGLE CARTRIDGE

- The motor shaft is driven by the rotor. Vanes, closely fitted into the rotor slots move radially to seal against the cam ring. The ring has two major and two minor radial sections joined by transitional sections called ramps. These contours and the pressures exposed to them are balanced diametrically.
- Light springs urge the vanes radially against the cam contour assuring a seal at zero speed so the motor can develop starting torque. The springs are assisted by centrifugal force at higher speeds. Radial grooves and holes through the vanes equalize radial hydraulic forces on the vanes at all times. Fluid enters and leaves the motor cartridge through opening in the side plates at the ramps. Each motor port connects to two diametrically opposed ramps. Pressurized fluid entering at Port A torques the rotor clockwise. The rotor transports it to the ramp openings which connect to Port B from which it returns to the low pressure side of the system. Pressure at Port B torques the rotor counter-clockwise.
- The rotor is separated axially from the sideplate surfaces by the fluid film. The front sideplate is clamped against the cam ring by the pressure, maintains optimum clearance as dimensions change with temperature and pressure. A 3-way shuttle valve in the sideplate causes clamping pressure in Port A or B, whichever is the highest.
- Materials are chosen for long life efficiency. Vanes, rotor and cam ring are made out of hardened high alloy steels. Cast semi-steel sideplates are chemically etched to have a fine crystalline surface for good lubrication at start-up.

PORTS AND HYDRAULIC FLUIDS - M3B AND M4* SERIES

PORTS EXTERNALLY DRAINED SINGLE CARTRIDGE MOTORS

These motors may be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure should not be subjected to more than 500 PSI. If it is necessary to exceed these limitations, please contact DENISON Hydraulics for application assistance.

INTERNALLY DRAINED TANDEM CARTRIDGE MOTORS

These motors must have a drain line connected to the center housing drain connection of sufficient size to prevent back pressure in excess of 50 PSI, and returned to the reservoir below the surface of the oil as far away from the supply pump suction as possible. Model M4DC1 does not require an external drain line, however the outlet pressure must not exceed 50 PSI.

INTERNALLY DRAINED MOTORS (M4C1, M4D1, M4E1, M4DC1)

May be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure must not be subjected to more than 22 PSI for M3B, 50 PSI for M4* (pressure peak 100 PSI).
To insure maximum motor performance in conjunction with your specific application, consult your DENISON Hydraulics Representative if your application requires :

- minimum speed of less than 100 RPM,
- indirect drive,
- overrunning loads,
- braking or retarding.

M4S SEVERE DUTY MOTORS

M4S motors are recommended to be used when back pressure is over 2000 PSI and speed is over 2000 RPM. They are also recommended when fluid viscosity can be under 115 SUS and speed over 2000 RPM. For such severe duty applications M4S motors will exhibity longer life time at high efficiency.

RECOMMENDED FLUIDS

Petroleum based antiwear R & O fluids.
These fluids are the recommended fluids for M3B and M4* series motors. Maximum catalog ratings and performance data are based on operation with these fluids. These fluids are covered by DENISON Hydraulics HF-0 and HF-2 specifications.
Acceptable alternate fluids :

ACCEPTABLE ALTERNATE FLUIDS

The use of fluids other than petroleum based antiwear R & O fluids requires that the maximum ratings of the motors will be reduced. In some cases, the minimum replenishment pressures must be increased. Refer to the following chart and the operating characteristics chart for each M3B and M4* motor model for specific details of the reduced ratings.

VISCOSITY

Max. (cold start, low speed & pressure)	3900 SUS
Max. (full speed & pressure)	500 SUS
Optimum (max. life)	140 SUS
Min. (full speed & pressure for HF-1 fluid)	89 SUS
Min. (full speed & pressure for HF-0 & HF-2 fluids)	59 SUS

VISCOSITY INDEX

90° min. Higher values extend range of operating temperatures and life time.

Maximum fluid temperature (θ) °F	
HF-0, HF-1, HF-2	+ 176°
Minimum fluid temperature (θ) °F	
HF-0, HF-1, HF-2	- 0.4°

FLUID CLEANLINESS

The fluid must be cleaned before and during operation to maintain contamination level of NAS 1638 class 8 (or ISO 18/14) or better. Filters with 25 micron (or better, ß10 ≥ 100) nominal ratings may be adequate but do not guarantee the required cleanliness levels.

OPERATING TEMPERATURES AND VISCOSITIES

Operating temperatures are a function of fluid viscosities, fluid type, and the pump. Fluid viscosity should be selected to provide optimum viscosity at normal operating temperatures. For cold starts the pumps should be operated at low speed and pressure until fluid warms up to an acceptable viscosity for full power operation.

WATER CONTAMINATION IN THE FLUID

Maximum acceptable content of water.

- 0,10 % for mineral base fluids.
- 0,05 % for synthetic fluids, crankcase oils, biodegradable fluids.

If amount of water is higher then it should be drained off the circuit.

SHAFTS AND MINIMUM REPLENISHMENT PRESSURE (PSI) - M3B AND M4* SERIES

SPLINED SHAFTS COUPLINGS SPLINES

- The mating female spline should be free to float and find its own center. If both members are rigidly supported, they must be aligned within .006 TIR or less to reduce fretting. The angular alignment of two spline axes must be less than ± .002 per 1".
- The coupling spline must be lubricated with a lithium molydisulfide grease or a similar lubricant.
- The coupling must be hardened to a hardness between 27 and 45 HRc.
- The female spline must be made to confom to the Class 1 fit as described in SAE-J498b (1971). This is described as a Flat Root Side Fit.

KEYED SHAFT

DENISON Hydraulics supplies the M3B and M4* series keyed shaft motors with high strength heat-treated keys. Therefore, when installing or replacing these motors, the heat-treated keys must be used in order to ensure maximum life in the application. If the key is replaced, it must be a heat-treated key between 27 and 34 R.C. hardness. The corners of the keys must be chamfered .03 to .04 at 45° to clear radii in the key way.

NOTE

Alignment of keyed shafts must be within tolerances given for splined shafts.

SHAFT LOADS

Axial or radial load are permissible. Consult specific sections for more details.

MINIMUM REPLENISHMENT PRESSURE (PSI)

Series	Speed [RPM] - Oil viscosity = 150 SUS				
	500	1000	2000	3000	3600
M3B	8.7	14.5	27.6	50.8	84.2
M4C/SC	10.2	20.3	45.0	79.8	135.0
M4D/SD	10.2	20.3	45.0	79.8	135.0
M4E/SE	20.3	40.6	75.5	159.6	
M4DC/SDC					
2-C-DC	24.7	55.1	145.1	325.1	410.7
2-D-DC	16.0	24.7	79.8	155.3	219.2
3-D-C-DC	24.7	55.1	145.1	325.1	410.7

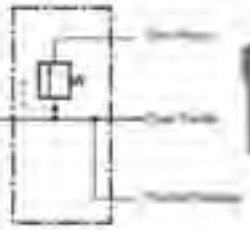
The inlet port of the fluid motor must be supplied with replenishment pressure as listed above to prevent cavitation during dynamic braking. These pressures should be multiplied by a coefficient of 1,5 for M4S motors used with fire resistant fluids (HF-3, HF-4, HF-5).
Replenishment pressure for tandem 2 & 3-speed motors must be provided during periods when the motor is dynamic braking, shutting down or coasting. When the motor is operating in the high speed mode and the nonworking cartridge is at low pressure, it is necessary to create a back pressure, as listed above, at the motor discharge port. The above mentioned minimum replenishment pressure chart is for maximum displacement cartridges. Smaller cartridges require lower minimum pressures.
Contact DENISON Hydraulics for further information.

Inlets (2500 psi)

End Inlet

Code	End Port	Top Port
DVA35-A440	1" NPT	1" NPT
DVA35-A880	SAE-16	SAE-16
DVA35-A980	SAE-20	SAE-16
DVA35-A000	NON-PORTED HOUSING	

NOTE: Inlets are machined for a main R/V or R/V plug and are furnished with plastic closures. See Section G, Page 32 for inlet port plugs

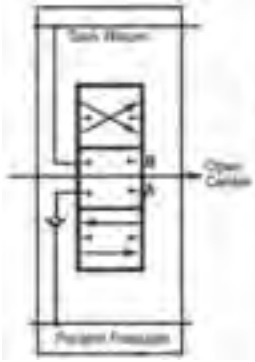


Note: For inlets with solenoid section pilot supply machining, see DVG35 inlet section E1

Adjustable Relief Valve Cartridges

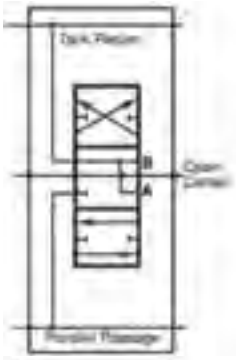
For Inlets and Mid-section Inlets

Code	Description
DVA35-MRV-1	Main R/V pressure range 800-2000 psi. Factory set @ 1500 psi @ 50 gpm
DVA35-MRV-2	Main R/V pressure range 2001-2500 psi. Factory set @2500 psi @ 50 gpm
DVA35-MRVP	Main relief valve plug



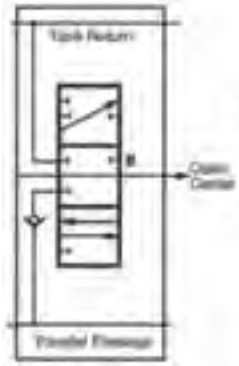
DA8

Double-Acting Section
4-Way, 3-Position, Hold in Neutral
Cylinder Spool



MA8

Double-Acting Section
4-Way, 3-Position, Float in Neutral
Motor Spool



SA8

Single-Acting Section
3-Way, 3-Position, Hold in Neutral
Cylinder Spool

Outlets

Tank Return Type

Code	End Port	Top Port
DVA35-TR55	1 1/4" NPT	1 1/4" NPT
DVA35-TR99	SAE-20	SAE-20
DVA35-TR00	NON-PORTED HOUSING	

NOTE: See Section G, Page 32 for Port Plugs

Brief Circuit Descriptions

Series Circuit

Available in DVA20 sections only.

If a machine's work cycle requires simultaneous as well as separate operation of individual hydraulic work functions, a series circuit is right for the job.

As with the other circuits, the oil flows through the open center when all spools are in neutral. There is no parallel passage in standard series sections because they feed directly from the open center passage. If more than one spool is operated, pump flow goes first to the section closest to the inlet. Return flow from the first section is fed back into the open center for use by downstream sections.

Downstream sections can be series, parallel or tandem and will operate in series with the upstream section.

In series circuits, operating pressure is cumulative. Therefore, the sum of the pressures in the circuits can not exceed the circuit or main relief valve setting.

Parallel Circuits

Parallel circuits are the most common on mobile equipment because more than one function can be operated simultaneously and at random. If two or more functions are fully operated at the same time, the one with the lightest load will assert priority because the fluid will take the path of least resistance. However, the operator can divide the flow between functions by metering the spools.

Movement of the spool meters or shuts off the flow of oil thru the open center passage and pressurizes the parallel passage. Oil is then available, at the operator's discretion, to all work ports connected to the parallel passage.

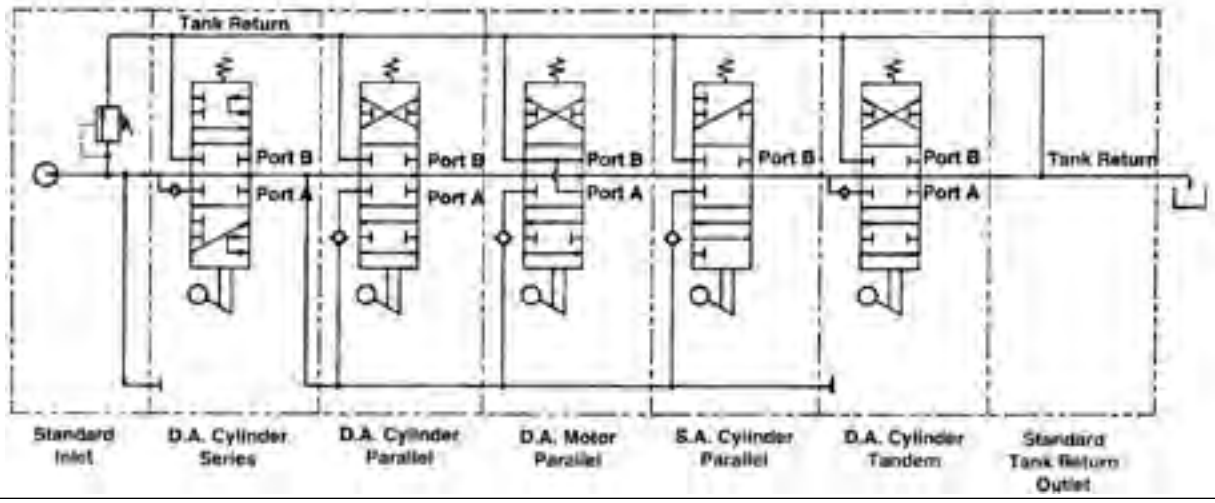
Tandem Circuits

(Not available in the program)

Tandem circuits are sometimes called priority or standard circuits by other manufacturers. Tandem sections feed from the open center passage like series sections but the return flow is directed to the tank return passage and is not available downstream.

If a tandem section is followed by a series or tandem section, operating the tandem section reserves the main will assert priority and downstream sections will not function.

Typical Work Section Schematics



VA™/VG™ Valve Service Instructions

INTRODUCTION

This manual has been prepared to assist you in the proper maintenance of the VA20™/VA35™ and VG20™/VG35™/VG80™ directional control valves. Before any work is done, we suggest that you read the assembly and disassembly instructions completely.

The first rule of good maintenance is cleanliness, which includes a clean environment. MAKE SURE YOU DISASSEMBLE AND ASSEMBLE YOUR HYDRAULIC EQUIPMENT IN A CLEAN AREA. Dirt is the natural enemy of any hydraulic system.

GENERAL INFORMATION

The VA and VG model valves are updated versions of our proven A20™ and A35™ units. The VG models are cast from compacted graphite, a high strength iron alloy, which allows the valve to be rated to 3500 psi. VA models are cast from gray iron and are rated at 2500 psi. These open-center, directional-control valves are available in parallel, tandem, and series circuitry. As needed, the sectional, stack-type construction provides flexibility for the addition of subtraction of work sections to an existing valve bank. This design also permits the combination of parallel, tandem, and series circuitry in a single bank. The internal coring of each valve section determines its circuitry and the number of gasket seals required.

All sections with optional features, such as port relief valves, crossover relief valves, and anti-cavitation checks, are dimensionally larger when measured from the top of the port to the bottom of the housing. These are referred to as "hi-boy" sections. Those without work-port options can use the low-profile castings, which are called "lo-boy" sections.

REPLACEMENT PARTS

The illustrations and instructions in this manual apply only to the VA/VG series assemblies, subassemblies, and components. All valve components, except for spools and housings, are available as replacement parts or subassemblies. Spools are hone-fitted to their individual housings, so damage to either of these components means the entire section must be replaced.

We recommend that you use only genuine VA/VG series replacement parts in your service program. Manufactured to the same exacting tolerances and quality controls as the original equipment, genuine VA/VG replacement parts may help prevent premature, component failure and costly downtime. Service parts and assemblies are available through your original equipment dealer or any authorized distributor.

MAINTENANCE

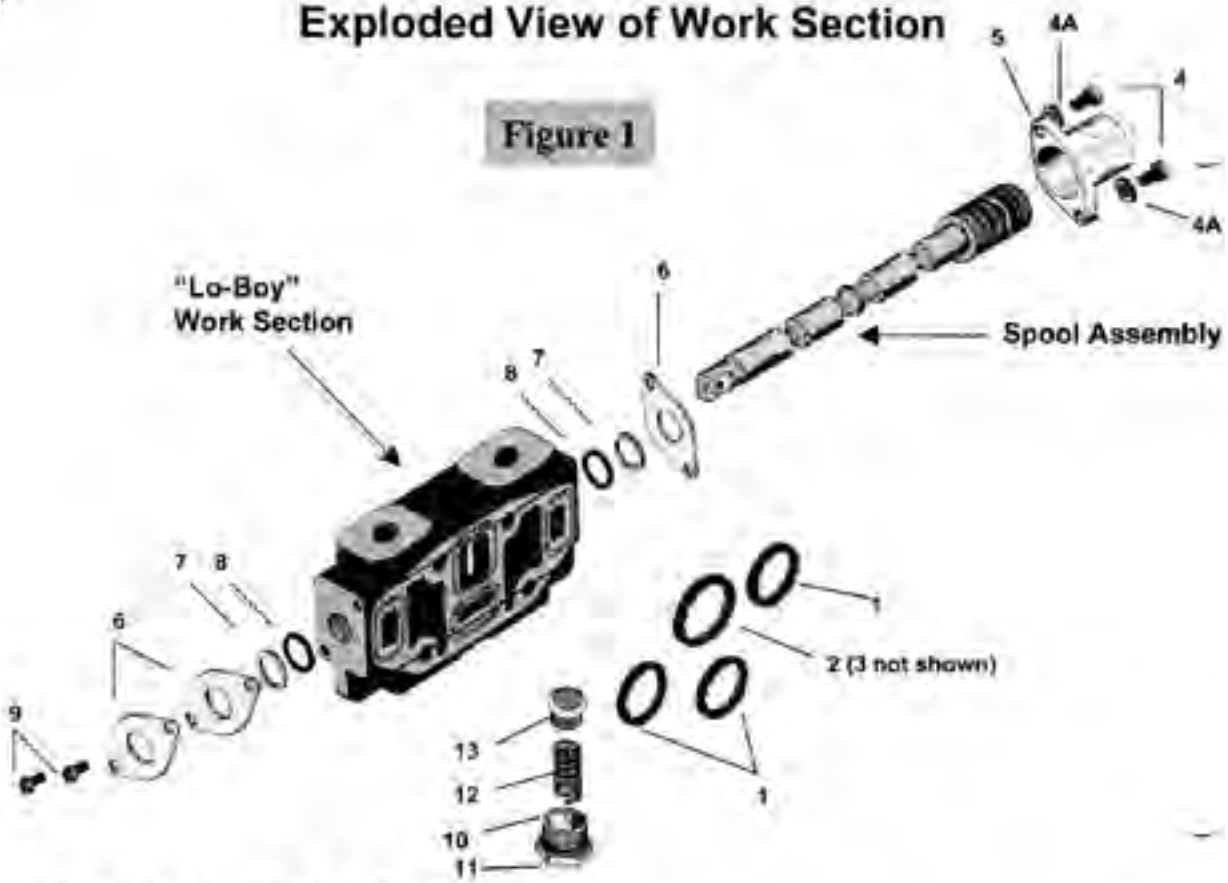
Valves are often used in hazardous environments. Inspect them frequently for damage due to improper use, corrosion or normal wear. If needed, repairs should be made immediately.

Always refer to the machine manual for the proper procedure to remove the valve from the machine.

Remove the valve bank from the equipment, disconnecting all hoses, fittings, control handles and linkage connectors that might be attached to the valve. Plug all ports and thoroughly clean the exterior of the valve bank, then the port plugs can be removed.

Exploded View of Work Section

Figure 1



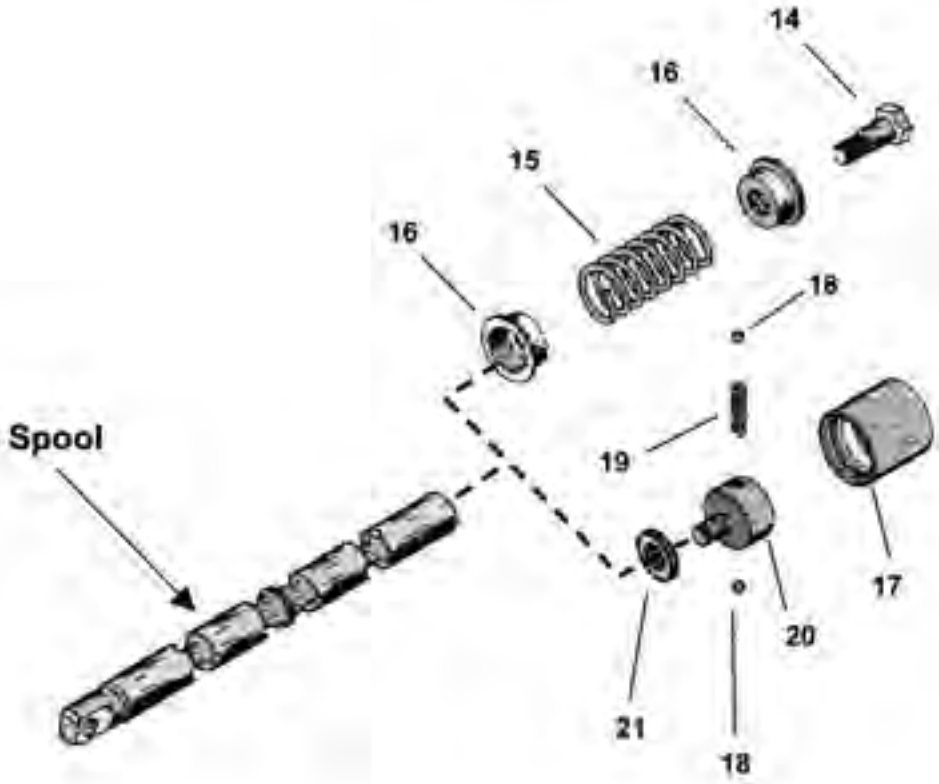
Parts List For Work Section

Item	Description	Qty.	VA/VG20 Part No.	VA/VG35 Part No.	VG80 Part No.
Parallel Section Seals* See Figure 1					
1.	Square Seals	3	391-2881-206	391-2881-200	391-2881-433
2.	Square Seal	1	391-2881-200	391-2881-403	391-2881-670
Series Section Seals					
1.	Square Seals	2	391-2881-206	391-2881-200	.....
3.	Square Seal	1	391-2881-627	391-2881-628	.....
Parallel and Series Section Component Parts. See Figure 1					
4.	Back Cap Screws	2	391-1433-020	391-1433-009	(4) 391-1402-068
4A.	Lock washers	8	.....	.....	391-3783-039
5.	Back Cap	1	341-6000-100	342-6000-100	341-0585-099
6.	Retainer Plates	3	391-2183-001	391-2183-005	391-2183-157
7.	Back up Rings	2	391-2681-378	391-2681-426	391-2681-285
8.	Spool Seals	2	391-1985-014	391-2887-212	391-2881-096
9.	Retainer Plate Screws	2	391-1433-015	391-1433-002	(4) 391-1402-015
10.	Check Valve Cap	1	391-0581-044	391-0581-044	391-0585-089
	Or Valve Cap (F.I.N.)	1	391-2281-015	391-2281-015	.....
11	O Ring Seal **	1	391-2881-204	391-2881-204	391-2881-249
12.	Check Spring **	1	391-3581-713	391-3581-713	391-3581-776
13.	Check Valve Poppet **	1	391-2481-069	391-2481-069	391-2383-091

*Parallel Sealing Face Includes inlets and mid-inlets.

**Not required in Float-in-neutral Sections.

Figure 2



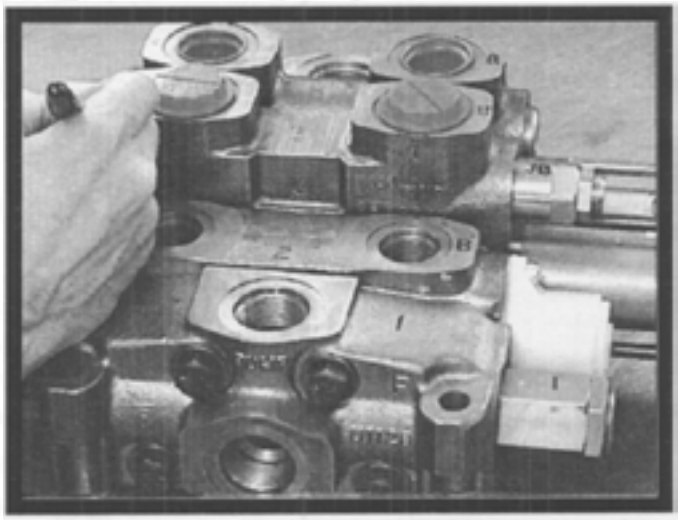
Spring Centered and Detent Spool Operators. See Figure 2

14.Stripper Bolt	1	391-1432-022	391-1432-021	391-1402-452
15.Centering Spring	1	391-3581-608	391-3581-633	391-3581-330
16.Spring Guides	2	391-1642-045	391-1642-013	391-1642-161
17.Detent Sleeve	1	391-3283-015	391-3283-008	391-3384-310
18.Detent Balls	2	391-0282-010	391-0282-009	391-0282-011
19.Detent Spring	1	391-3581-130	391-3581-015	391-3581-316
20.Detent Poppet Retainer	1	391-2583-008	391-2583-006	391-3384-311
21.Detent Spacer	1			391-3782-208

4

Valve Disassembly Instructions

Reference exploded view and parts list on page 2 and 3 for work section detail.



Step 1 - Valve Bank

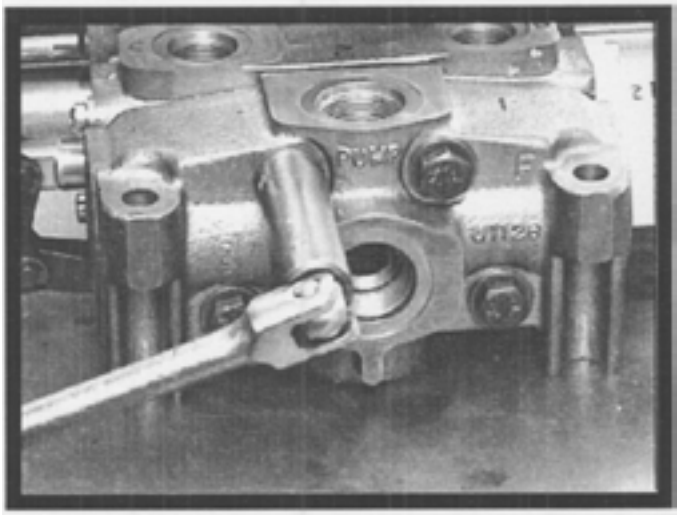
This step is the most critical in the disassembly procedure. It should be followed closely to ensure that the valve bank is properly reassembled after repairs have been made.

With a waterproof, quick-drying marker, mark each casting with a sequential number. Start by marking the inlet casting with the #1 and finish by marking the outlet with the highest number.

Next, mark the port boss closest to the tack cap on each work section with a "B" (for back cap end).

Then, mark the port boss closest to the spool clevis on each work section with a "C" (for clevis end).

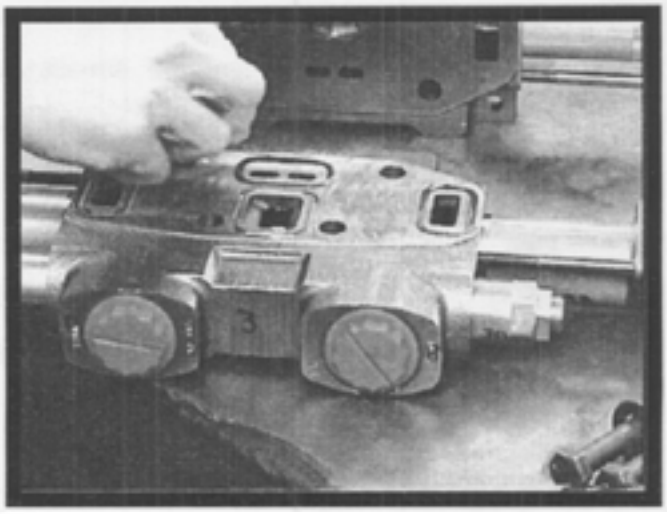
Finally, if relief valves are removed from the valve bank, they must be marked with the corresponding number of the casting and port location (B or C) from which they were removed. Inlet and mid-inlet relief valves are marked with a casting number only.



Step 2 - Tie Bolts

Remove the four, tie bolts that hold the bank together and separate the sections.

NOTE: VA valve tie bolts thread into the outlet casting. VG valve tie bolts pass through the entire bank, requiring washers and hex nuts to be fastened at both ends of the bolt.



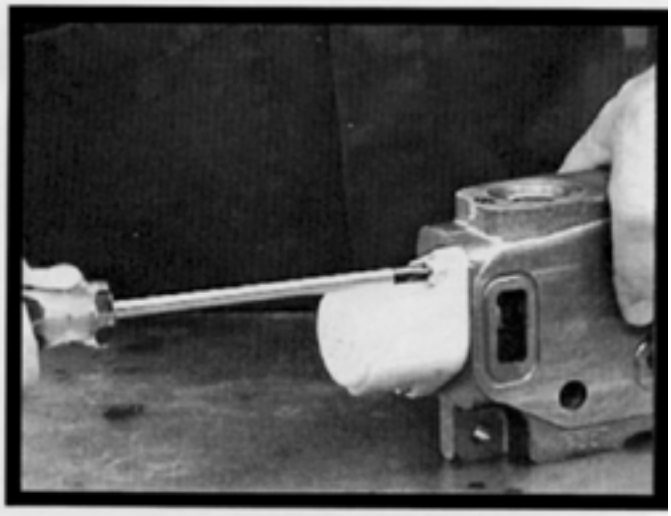
Step 3 - Section Seals

The inlet, mid-inlet and each parallel work section have four, section seals. (Fig. 1, items 1 & 2) on the downstream, mating face. Series work sections and the VA/VGJ5 split flow mid inlets have three section seals on the downstream mating face. (Fig. 1, items 1 & 3.) These section seals should be removed and discarded.

REMINDER: ALL WORK MUST BE PERFORMED IN A CLEAN AREA.

Valve Disassembly Instructions

5



Step 4 - Valve Back Cap

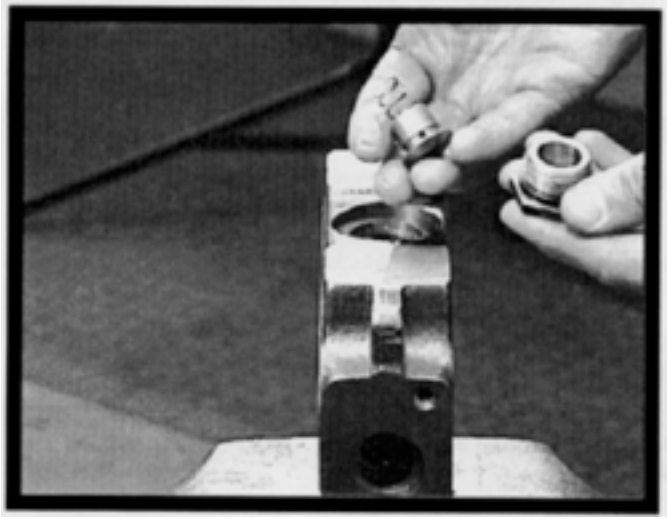
Using a large, Phillips-head screwdriver, remove the two, cap screws (Fig. 1, item 4) which fasten the back cap to the work section. Lightly tap the end of the screwdriver handle with a hammer to break adhesive. Remove the back cap (Fig. 1, item 5).

Step 5 - Control Spool and Seals

Grasp the spring end of the spool with a clean, lint-free cloth and pull the spool out of the housing using a twisting motion. Generally, the rear, retainer plate (Fig. 1, item 6) back-up ring (Fig. 1, item 7) and spool seal (Fig. 1, item 8) will come out with the spool.

CAUTION: For detented spool models, be careful not to remove the detent poppet sleeve (Fig. 2, item 17) unless it is to be serviced.

Using a large, Phillips-head screwdriver, remove the two, retainer-plate screws (Fig. 1, item 9) from the spool clevis end of the work section. Lightly tap the end of the screwdriver handle with a hammer to break the adhesive. Remove the two retainer plates (Fig. 1, item 6) the back-up ring (Fig. 1, item 7) and the spool seal (Fig. 1, item 8). Tag or mark with the appropriate, work section identification number. (See Step 1.) Spool seals (Fig. 1, item 8) and back-up rings (Fig. 1, item 7) should be discarded.



Step 6 - Transition Check

The transition check is located in the bottom center of the work section housing. Carefully clamp the work section in a vise with ports down. Do not clamp on the machined surface. Remove the check-valve cap (Fig. 1, item 10) and its O-ring seal (Fig. 1, item 11). Discard the seal. Remove the check spring (Fig. 1, item 12,) and the check-valve poppet (Fig. 1, item 13).

NOTE: Only cylinder work sections (ports blocked in neutral) have a transition check. Motor sections have only a cap plug.

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Valve Disassembly Instructions

Spool Disassembly

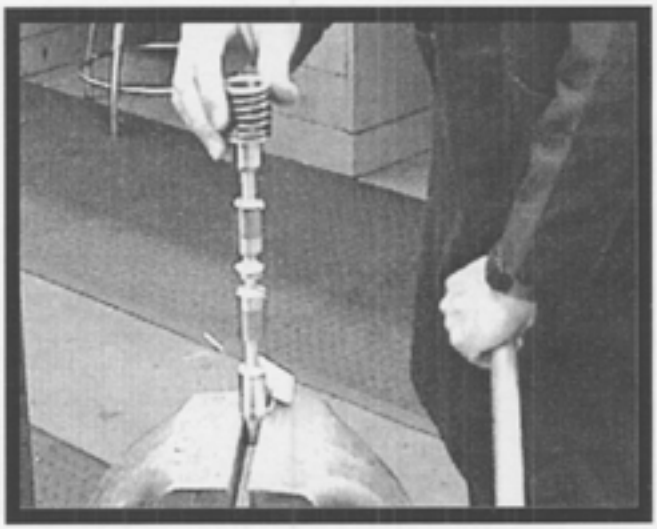
Spring Centered Spool

The spring assembly should not be removed from the spool unless these parts need to be replaced. Once the spool is free of the work section housing, it must be handled carefully to avoid damage. Place the spool vertically in a soft-jawed vise, clamping on the flat spool clevis, and remove the stripper bolt (Fig. 1, item 14) with a wrench.

Lightly tap the stripper bolt with a hammer and a punch to help break the adhesive. Cautious application of heat may be required to free the stripper bolt, since an anaerobic thread adhesive was used during its assembly.

CAUTION: Too much heat may distort the spool.

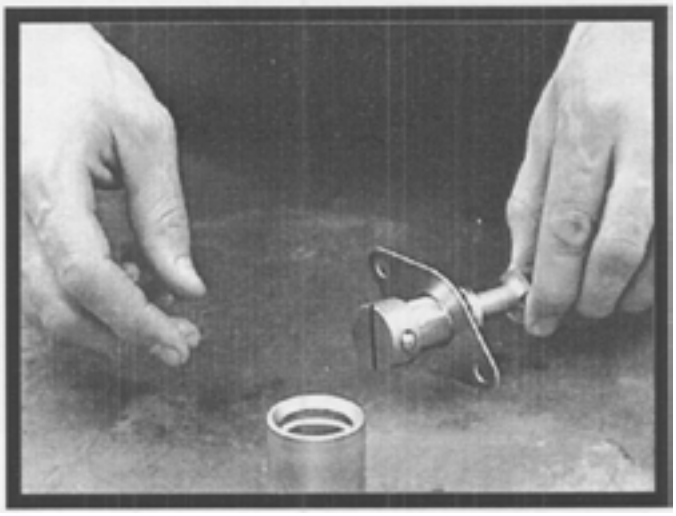
As the stripper-bolt threads disengage, the spring (Fig. 2, item 15) and spring guides (Fig. 2, item 16) will release abruptly from the spool.



Detent Spool

The detent assembly should not be removed from the spool unless these parts need to be replaced. Wrap the detent sleeve (Fig. 2, item 17) with a clean, lint-free cloth. Grip the cloth-covered sleeve and pull firmly. As the sleeve moves backwards, the detent balls (Fig. 2, item 18) and the detent spring (Fig. 2, item 19) will release abruptly. The cloth should capture these parts and prevent their loss.

Next, clamp the spool in a soft-jawed vise and remove the detent poppet retainer (Fig. 2, item 20). Place an undersized bar through the detent ball bore to serve as a wrench. Lightly tap the detent poppet retainer with a hammer and a punch to help break the adhesive. Cautious application of heat may be required again, since an anaerobic adhesive was also used in the detent retainer assembly.



CAUTION: Too much heat may distort the spool!

CLEANING, INSPECTION, AND REPAIR

1. Inspect the spool bore, transition check seat and spool from each section for deep scratches, gouges or excessive wear. If any of these conditions exist, replace the section. Minor surface damage on the control spool and check poppet can be carefully polished away with a very fine, crocus cloth.

2. Examine the machined surfaces of the valve housing for nicks and burrs that could cause leakage between sections. Lightly stone these surfaces to remove any rough spots.

CAUTION: A shallow-milled relief area extends across the O-ring face of the valve housing. This should not be stoned or ground off!

3. Wash all parts thoroughly in a cleaning solvent and blow dry before beginning reassembly. Pay special attention to the number and letters marked on the parts in Step 1. If any marks are removed during cleaning, remark immediately.

4. Clean adhesive from threads of spool, stripper bolt, housing, cap screws and hex nut with Loctite® Chisel Gasket Remover.

Valve Assembly Instructions

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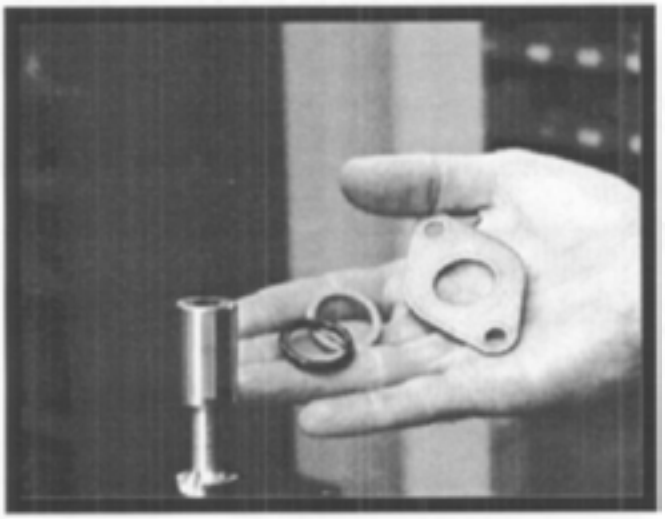
Preparation of Parts

Spray the threads of the new stripper bolt (Fig. 2, item 14) tapped-threaded spool end, all screws and screw holes on both ends of the housing with LOCQUIC Primer Grade NF™ and let dry

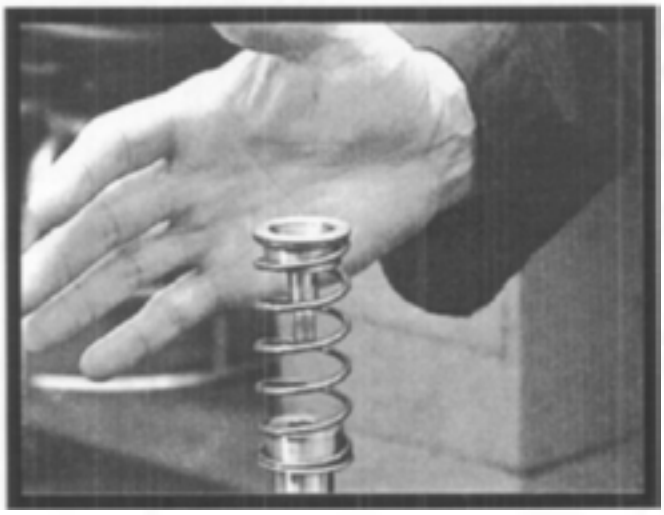
CAUTION: Failure to follow the recommended assembly instructions can result in poor performance or product malfunction. Product should be thoroughly tested to ensure proper operation before the valve is placed back into service.

Spring Center Spool Assembly



Step 1 - Spool Assembly-Spring Centered

Clamp the flat, clevis end of the control spool in a soft jawed vise. Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8) and slide it onto the end of the spool away from the clevis. Slide on the back-up ring (Fig. 1, item 7) and retainer plate (Fig. 1, item 6). Position these items onto the spool, so that they do not interfere with the spool operator mechanism during assembly. Do not allow the O-ring to come in contact with the sharp edge of the spool notches



Step 2 - Attach Spring Guides and Spring

Apply 2 - 3 drops of Loctite 262™ or equivalent anaerobic adhesive near the middle of the female threads in the spool. Assemble the spring guides (Fig. 2, item 16) centering spring (Fig. 2, item 15) and stripper bolt (Fig.2, item 14,) onto the spool (Reverse of Step 7). Torque the stripper bolt to 175 in. lbs. +/-4 in lbs

CAUTION: Care must be taken to ensure that the spring retainer is not pinched under the shoulder bolt during assembly. This can result in burrs that may cause spool binding. Check for binding by compressing the spring and guides or by rotating the spring guide nearest the housing.

CAUTION: Follow the adhesive manufacturer's instructions for proper cleaning and curing. Failure to clean and prepare parts properly may result in assembly failure!

Lightly coat the centering spring with high- temperature grease to prevent rusting. Set the spool assembly aside and let it cure for a minimum of 1 hour. After curing, test the stripper bolt to make certain it can withstand 125 in. lbs. of breakaway torque.

8

Valve Assembly Instructions

Detent Spool Assembly

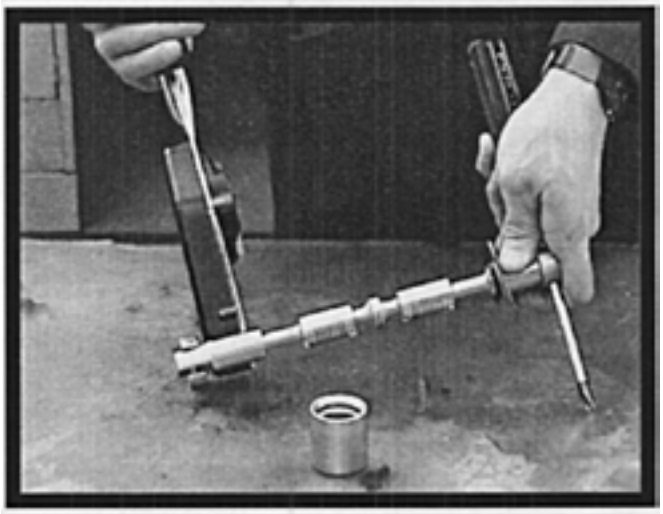
Step 1 - Spool Assembly-Detent

Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8) and slide it onto the spool. Slide the back-up ring (Fig. 1, item 7) and one, retainer plate (Fig. 1 item 6) onto the spool. Position these items onto the spool, so that they do not interfere with the spool operator mechanism during assembly. Do not allow the O-ring to come in contact with the sharp edge of the spool notches. Apply 2 - 3 drops of Loctite 262™ or an equivalent, anaerobic adhesive near the middle of the female threads in the spool.

CAUTION: Follow the adhesive manufacturer's instructions for proper cleaning and curing. Failure in clean and prepare parts properly may result in assembly failure.

Step 2 - Spool Assembly-Detent

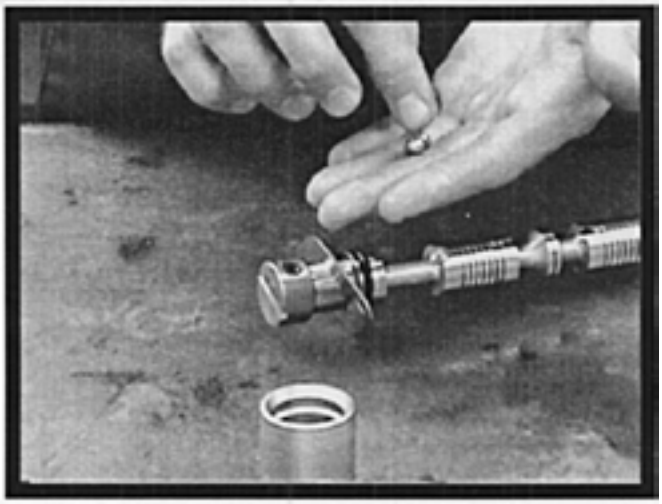
Thread the detent ball retainer (Fig. 2, item 20) into the spool end. Torque the detent ball retainer to 175 in. lbs. +/-4 in. lbs.. This can be accomplished by using a cross-flats socket on the flats of the clevis, and holding the spool by inserting a round, steel rod or screwdriver through the hole in the ball retainer.



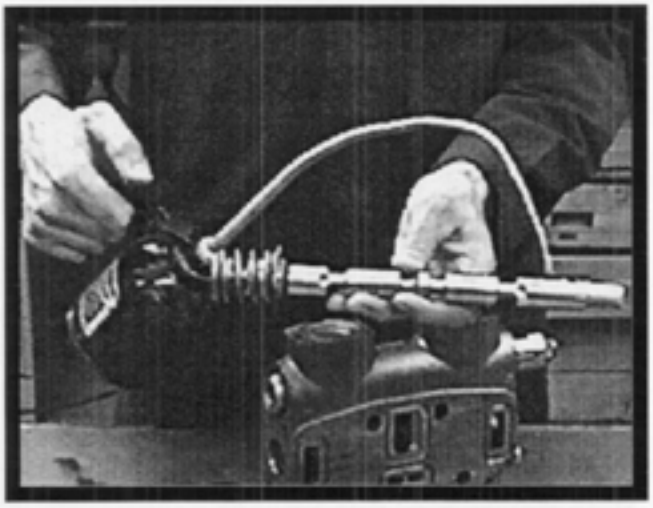
Step 3 - Detent Balls and Spring

Next, lightly coat the detent balls (Fig. 2, item 18) detent spring (Fig. 2, item 19) and entire inside diameter of the detent sleeve (Fig. 2, item 17) with high-temperature grease.

Insert the detent spring into the through hole in the detent ball retainer. Place the steel balls on the ends of the spring. Compress the balls and spring, then slip on the detent sleeve. (Note: The detent sleeve is not symmetrical; one end of the sleeve has a lead-in chamfer. This chamfer must face the spool clevis when assembled.) Move the detent sleeve to the neutral or middle position to prevent the subassembly from separating during subsequent steps.



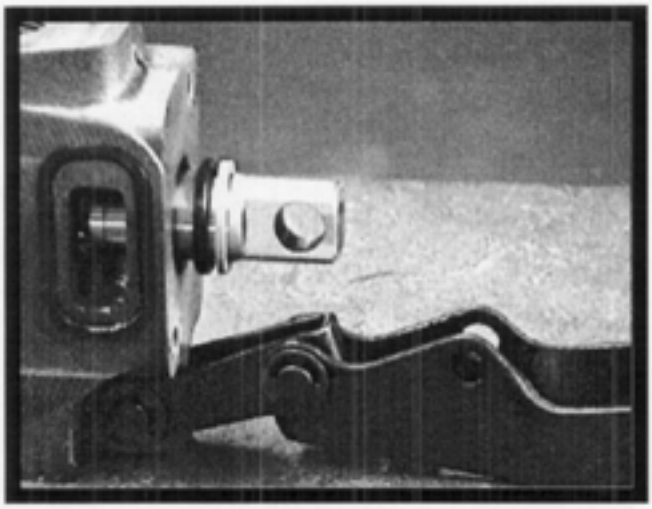
Valve Assembly Instructions



Step 1 - Spool Subassembly

Apply 2 - 3 drops of Loctite 262™ or equivalent to the fillister screw holes in both ends of the housing.

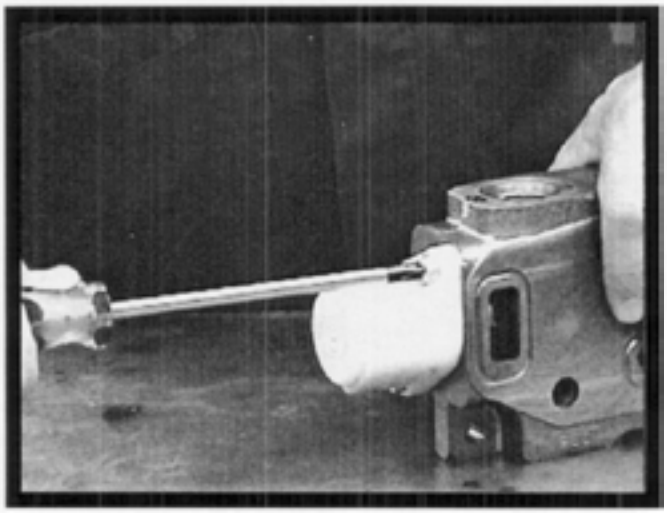
Apply a light coating of clean, hydraulic oil to the valve spool. Carefully insert the spool assembly into the housing. Use caution to avoid causing burrs. Be careful not to pinch, roll or damage the seals. Make sure that the spool and housing are in the proper orientation (see Step 1, page 6 disassembly).



Step 2 - Spool Seal and Back up

Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8) and slide it onto the spool. Slide on the back-up ring (Fig. 1, item 7). Push both items into the counter-bore until they bottom out.

Assemble the two, front, retainer plates (Fig. 1, item 6) using the two short, fillister screws (Fig. 1, item 9). Check retainer plates for proper alignment. Tighten to a final torque of 34 in. lbs. +/- 2 in. lbs.



Step 3 - Back cap

Install the back cap using the two, long, fillister screws (Fig. 1, item 4). Tighten to a final torque of 34 in. lbs +/- 2 in. lbs.

Caution: Excessive torque will damage the back cap ears!

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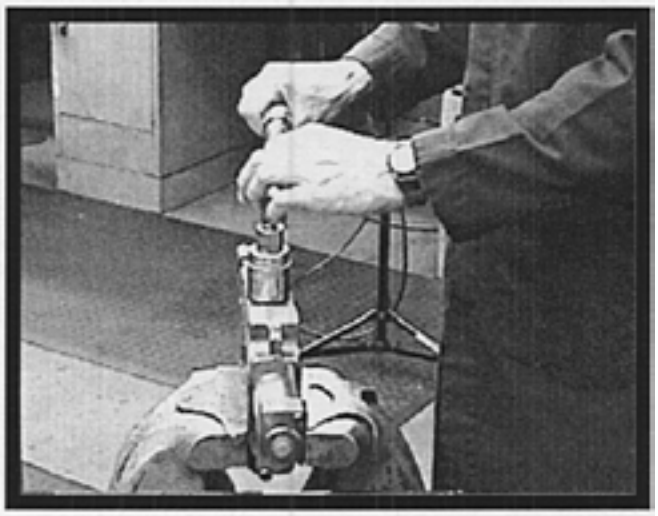
Valve Assembly Instructions

Step 4 - Install Transition Check

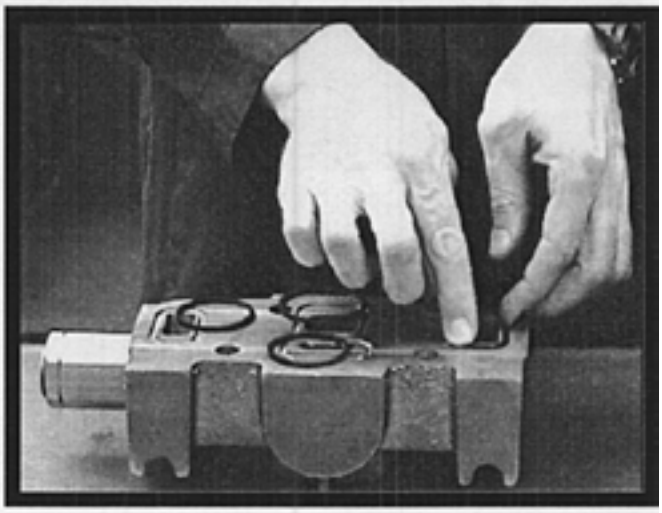
Inspect transition check components for cleanliness. Install check poppet (Fig. 1, item 13) into the transition check cavity. Align the check spring (Fig. 1, item 12) square to the poppet, then carefully place the check cap (Fig. 1, item 11) over the poppet and spring. Turning by hand, engage several threads. Tighten to a final torque of 75 ft. lbs. +/-4ft. lbs.



Step 5 - Relief Valves

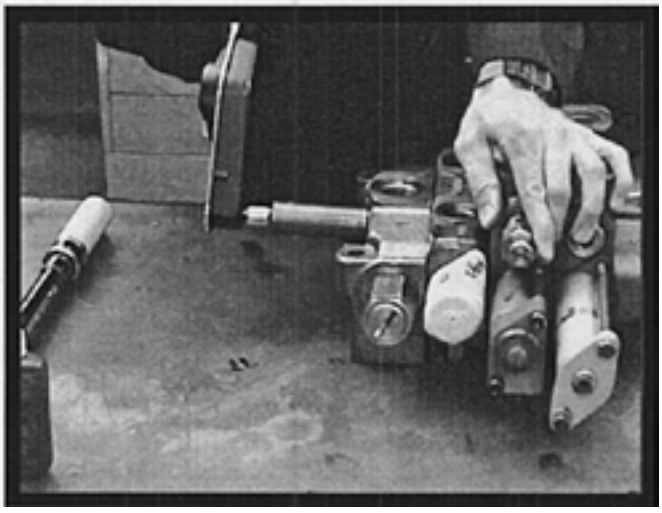
Return all relief valves to their proper positions and torque to 75 ft. lbs.

Install new, section seals. Place section seals (Fig. 1, items 1 & 2, or items 1 & 3) in the proper grooves. Make certain seals stay in their grooves during assembly.



Step 6 - Install Tie Bolts

Slide the tie bolts through the inlet casting. If cap screws are used, place a washer on the cap screw prior to installation. Place the valve sections on the tie bolts in their proper sequence (see Step 1, page 4). Turning by hand, engage several threads in the outlet. If it is a VG series assembly, assemble nut and washer to either end of the stud and follow above instructions. Torque the tie bolts in a cross-corner pattern.



Tie Bolt Torque Values

VA20 - 29 ft. lbs. (348 in. lbs.)
VG20 - 42 ft. lbs. (504 in. lbs.)
VA35 - 34 ft. lbs. (408 in. lbs.)
VG35 - 75 ft. lbs. (900 in. lbs.)
VG80 - 150 ft. lbs. (1800 in. lbs.)

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Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Oil leaks between sections	Pinched, blown or missing section seal	Replace section seal
	Stud fasteners not correctly torqued	Replace section seals and re-torque
	Mounting plate not level	Loosen mounting bolts and shim as required
	Contamination/burrs on seal	Clean seal groove, replace section seal
Oil leaks at either end of spool	Over-pressurized tank core	Correct high, back-pressure condition
	Worn or damaged spool seals	Replace seals and seal retainers
Spring - centered spools do not return to neutral	Broken centering spring	Replace centering spring
	Misalignment of operating linkage	Check linkage for mechanical binding
	Foreign particles in system	Clean valve and system
Load will not hold	Cylinder leaking or worn	Check cylinder - repair
	Port relief valve not holding	Remove and clean or replace
	Spool or housing scored or worn excessively	Replace section
Load drops when spool moved from neutral	Dirt or foreign particles lodged between check-valve poppet and seat	Disassemble, clean & reassemble
	Scored or sticking check-valve poppet	Replace poppet
No motion, slow, or erratic system operation	Worn pump	Check flow & pressure
	Defective cylinder or motor	Repair or replace
	Low-reservoir oil level	Add oil to specifications
	Clogged suction strainer	Clean or replace
	Suction line restricted	Check lines
	Relief valve not properly set	Check pressure setting
	Relief valve poppet or seat scored & sticking open	Replace relief valve
	Valve spool not shifted to full stroke	Check spool linkage travel

Pilot-to-open, spring biased closed, unbalanced poppet logic element

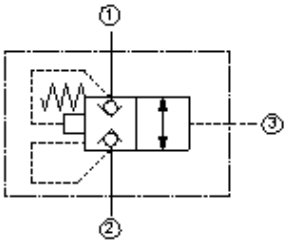
Capacity:
60 gpm (240 L/min.)

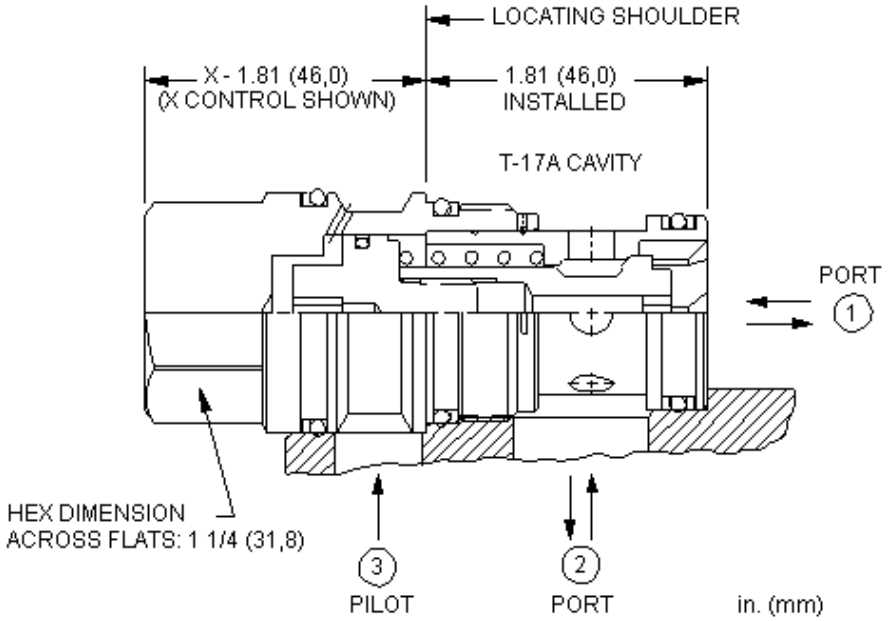
Functional Group:
Products : Cartridges : Corrosion Resistant : Logic Element : Unbalanced Poppet, Pilot-to-open, Switching Element, Spring biased closed, External Pilot Port 3 pilot source

Model:
LKHC

Product Description

These unbalanced poppet, logic valves are 2-way switching elements that are spring-biased closed. Pressure at either work port 1 or 2 will further bias the valve to the closed position while pressure at port 3 will tend to open it. The force generated at port 3 must be greater than the sum of the forces acting at port 1 and port 2 plus the spring force for the valve to open. NOTE: The pilot area (port 3) is 1.8 times the area at port 1 and 2.25 times the area at port 2.





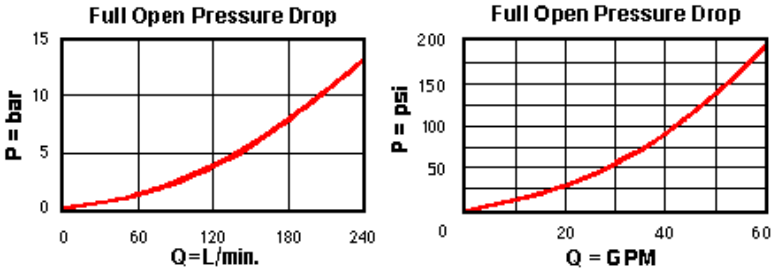
Technical Features

- Because these valves are unbalanced, operation is pressure dependent. Opening and closing of the poppet are functions of the force balances on three areas: 1) Port 1 = 100%, Port 2 = 80%, and Port 3 = 180%.
- These valves are pressure responsive at all three ports, therefore it is essential to consider all aspects of system operation through a complete cycle. Pressure changes at any one port may cause a valve to switch from a closed to an open position, or vice versa. All possible pressure changes in the complete circuit must be considered to assure a safe, functional system design.

- These valves have positive seals between port 3 and port 2.
- Incorporates the Sun floating style construction to eliminate the effects of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.
- Stainless steel cartridge options P or W are intended for use within corrosive environments with all external components manufactured in stainless steel or titanium. Internal working components remain the same as the standard valves.

Technical Data

	U.S. Units	Metric Units
Cavity	T-17A	
Capacity	60	240 L/min.
Area Ratio, A3 to A1	1.8:1	
Area Ratio, A3 to A2	2.25:1	
Maximum Operating Pressure	5000	350 bar
Maximum Valve Leakage at 110 SUS (24 cSt)	10	10 drops/min.@70 bar
Pilot Volume Displacement	.15	2,5 cc
Series (from Cavity)	3	
U.S. Patent #	4,795,129	
Valve Hex Size	1 1/4	31,8 mm
Valve Installation Torque	150 - 160	200 - 215 Nm
Seal Kits	Buna: 990-017-007	
Seal Kits	Viton: 990-017-006	



Option Selection

LKHC-X D N

Preferred Options

Control	*Cracking Pressure*	*External Material/Seal Material*

Standard Options

X Not Adjustable		**N** Buna-N
		V Viton